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HE MAGAZINE OF THE WORLDWIDE ELECTRONICS INDUSTRY

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MICROWAVE CIRCUITS GO MONOLITHIC

NEW CHIPS CAST SHADOW OVER TRADITIONAL HYBRIDS
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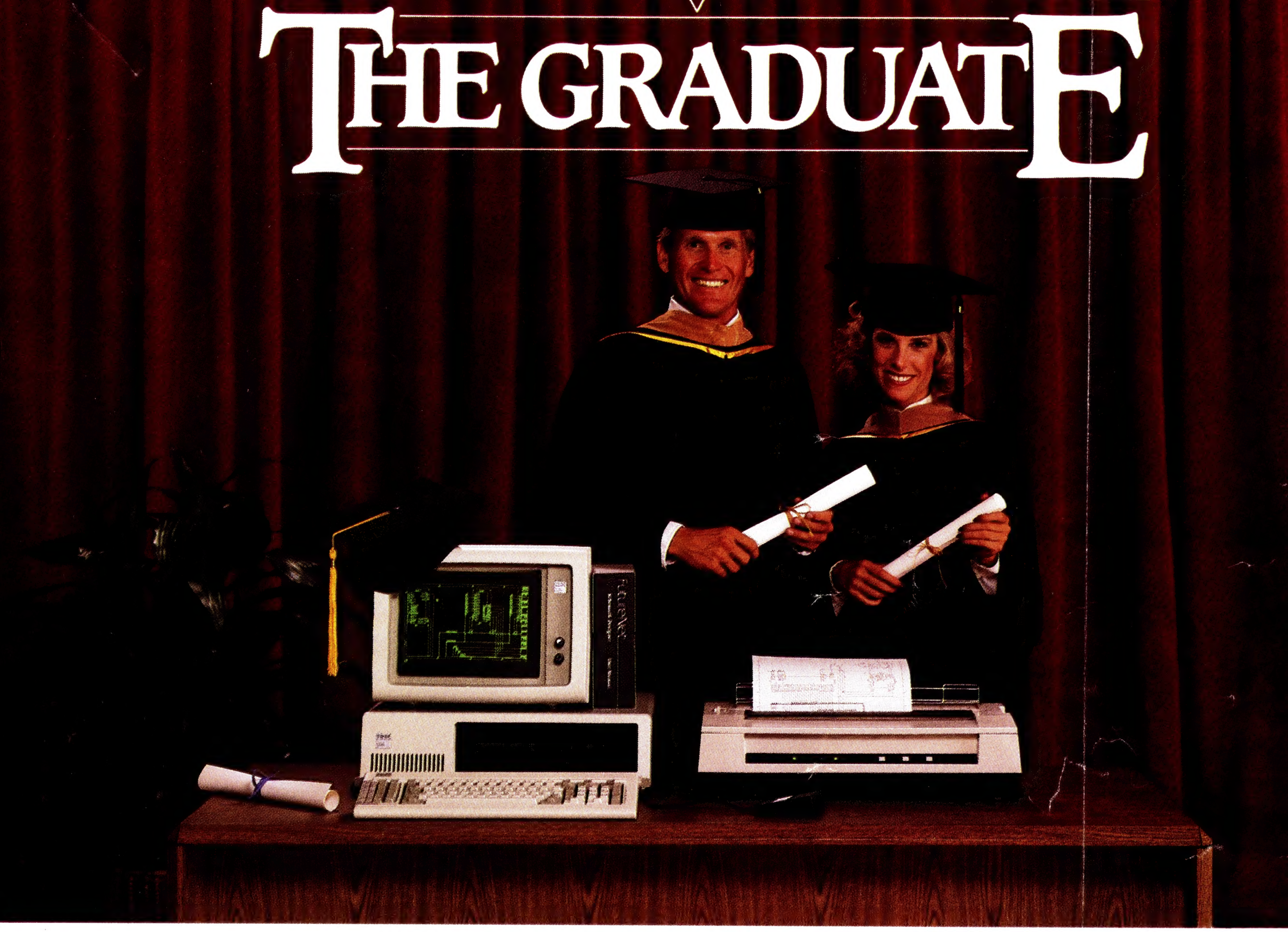

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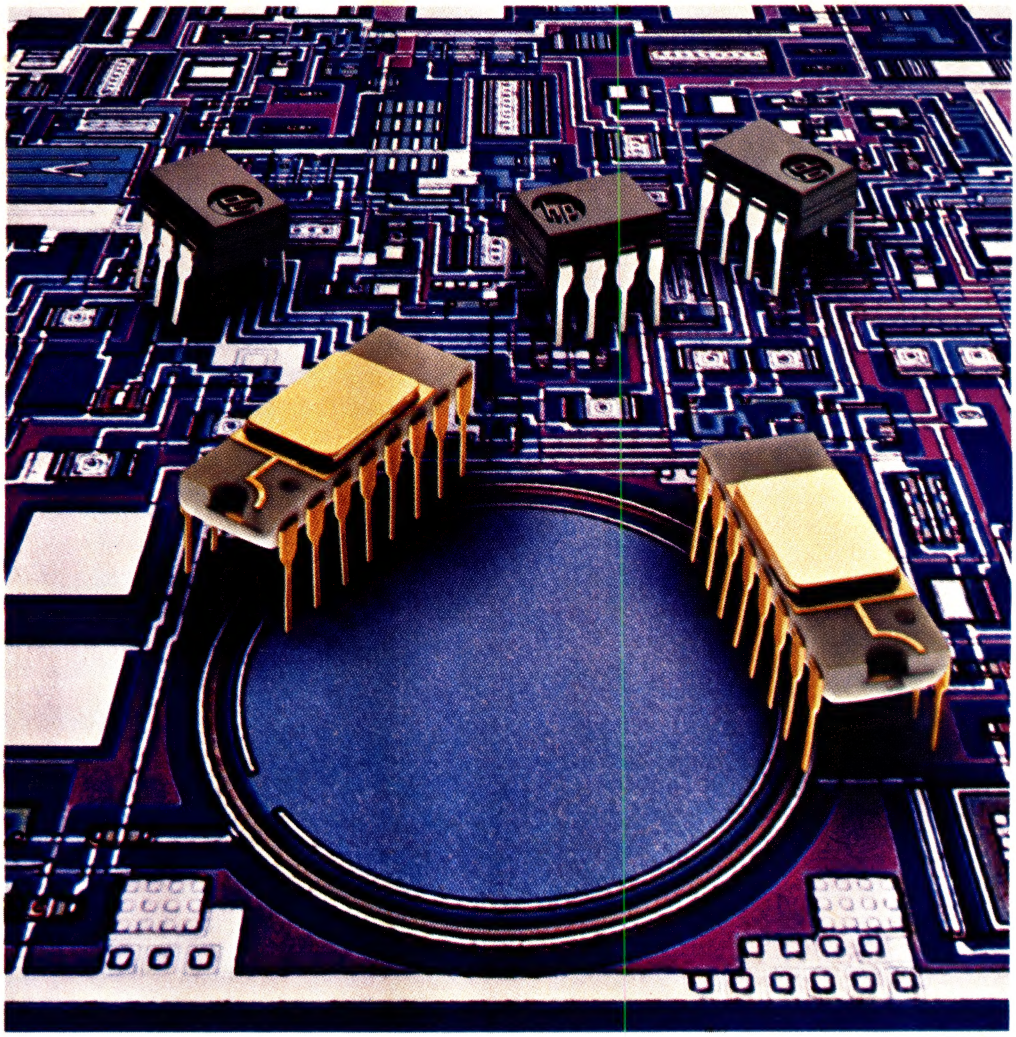

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Next ElectronicsWeek

Semiconductor makers face their mid-life crisis

The semiconductor business was born about 40 years ago, and since then chip merchants have made fast fortunes living a boom-and-bust life while defying the supply-and-demand rules that govern most other industries. But having reached mid-life, the industry finds itself at best confused and at worst riddled with doubt about its coming middle age. The problem is not so much longevity as it is direction. The sheer steepness of the latest market fall, greater global competition, and the sudden collapse of a promising young personal computer market are sowing the seeds of the semiconductor industry's mid-life crisis. For an insightful and thoughtful analysis of what's ahead, see the next issue of *ElectronicsWeek.*

Times are good but things are bad

The growth of computer graphics has been nothing if not steady: graphics has even found its way into personal computers. But if that's the case, why are so many graphics companies in trouble this year? The answer, in part, lies in the technology itself. For the full story, see the next issue.

Looking ahead in ElectronicsWeek

The latest standings of the 32-bit league

When semiconductor and computer-systems manufacturers talk about 32-bit microprocessors, they give the impression that they are involved in a life-and-death conflict—symbolically, of course—for domination of the marketplace. They see themselves as participating in a market war that could determine, for the rest of this century at least, the commercial pecking order in the electronics industry. What is on the market and who's ahead? For the latest scorecard, see the June 3 issue of *ElectronicsWeek.*

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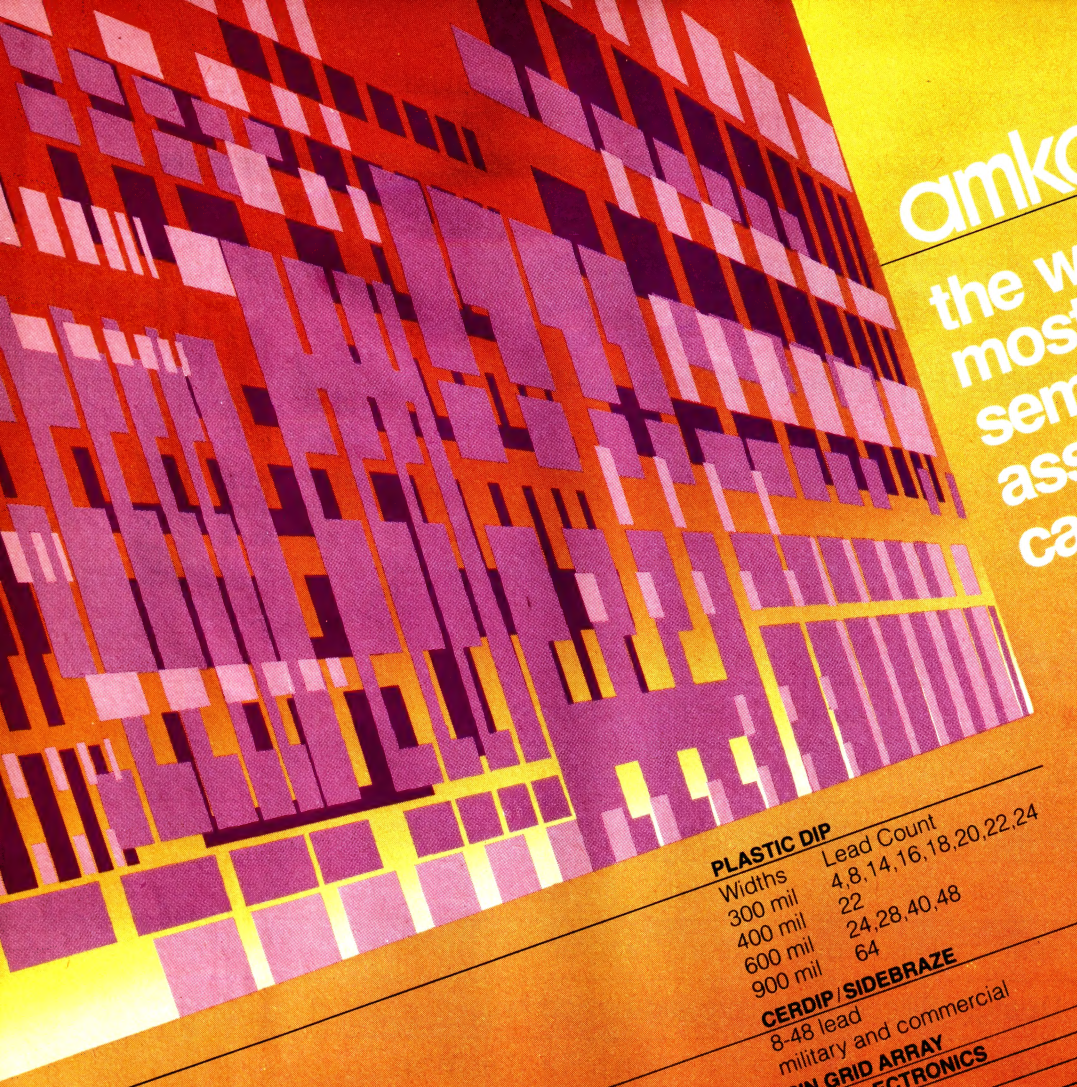

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THE BIG DEAL FOR MITEL

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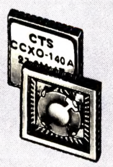

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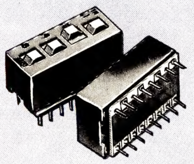

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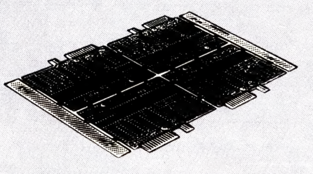

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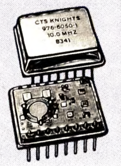

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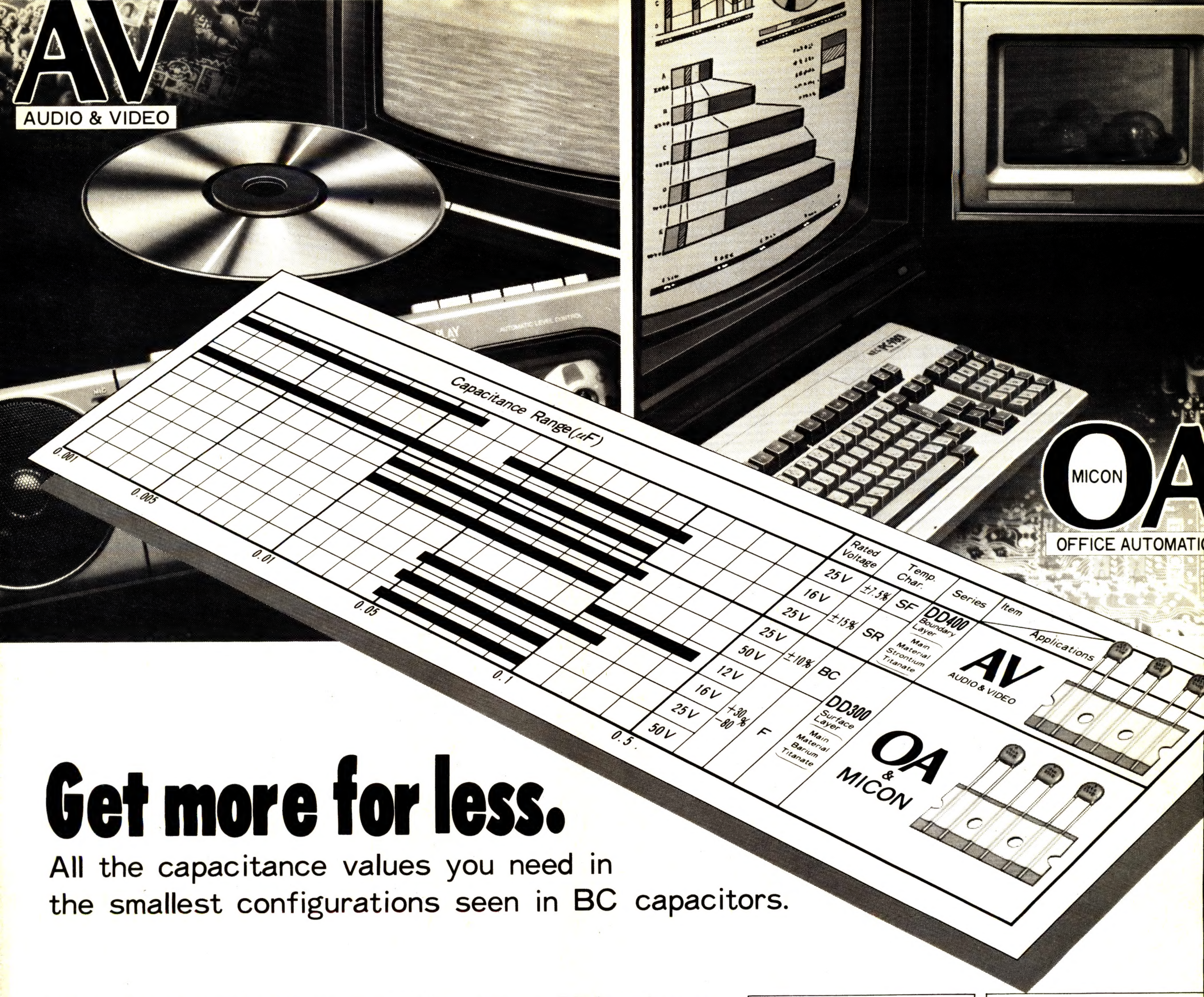

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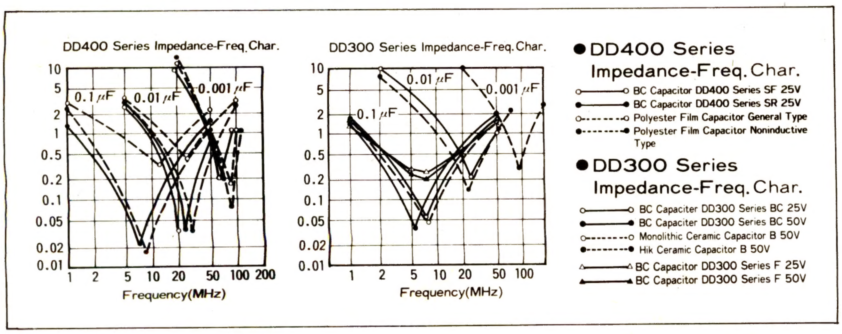
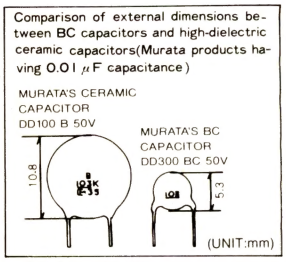
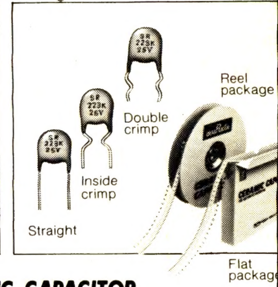



Comparison of external dimensions between BC capacitors and high-dielectric ceramic capacitors(Murata products having 0.01 μF capacitance)
MURATA'S CERAMIC CAPACITOR DD100 B 50V
10.8
MURATA'S BC CAPACITOR DD300 BC 50V
5.3
(UNIT:mm)



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MEETINGS

Nepcon East '85, Cahners Exposition Group (Cahners Plaza, 1350 E. Touhy Ave., Des Plaines, Ill. 60018), Bayside Exposition Center, Boston, June 19-21.

Symposium on Artificial Intelligence, National Bureau of Standards *et al.* (Public Information Division, NBS, Gaithersburg, Md. 20899), NBS Building, Gaithersburg, Md., June 20.

Resna '85—8th Conference on Rehabilitation Technology, Rehabilitation Engineering Society of North America (1101 Connecticut Ave. N.W., Washington, D.C., 20036), Peabody Hotel, Memphis, Tenn., June 21-28.

ICC-85—International Conference on Communications 1985, IEEE (ICC-85, P.O. Box 1147, Lombard, Ill. 60148), Palmer House, Chicago, June 23-26.

Second Software Strategies Forum, Gartner Group Inc. (72 Cummings Point Rd., Stamford, Ct. 06902), Hyatt Regency Hotel, Monterey, Calif., June 24-26.

International Electronic Printer Industry Conference, C.A. Pesko Associates Inc. (1 Snow Rd., Marshfield, Mass. 02050), Brussels, Belgium, June 24-26.

VLSI Multilevel Interconnection Conference, IEEE (Microelectronics Research Laboratory, P.O. Drawer EE, Mississippi State University, Mississippi State, Miss. 39762), Santa Clara Marriott Hotel, Santa Clara, Calif., June 24-26.

Videotex '85 International Conference and Exhibition, Online Conferences Inc. (989 Avenue of the Americas, New York, N.Y. 10018), New York Hilton, New York, June 24-26.

Network Management/Technical Control Conference and Exposition, Arus Inc. *et al.* (NM/TC Conference and Exposition, P.O. Box 880, Framingham, Mass. 01701), Convention Center, San Jose, Calif., June 24-27.

Power Electronics Specialists Conference, IEEE and European Space Agency (William W. Burns III, Data General Corp., 4400 Computer Dr., Westboro, Mass. 01580), University Paul Sabatier, Toulouse, France, June 24-28.

Computer Graphics '85 West, National Computer Graphics Association (8401 Arlington Blvd., Fairfax, Va. 22031), Los Angeles, June 25-27.

Computer Storage Industry Conference, Dataquest Inc. (1290 Ridder Park Dr., San Jose, Calif. 95131), The Registry, Phoenix, Ariz., June 25-27.

VCC/East—8th Visual Communications Congress, Graphic Media Inc. (VCC Conference Headquarters, 2378 S. Broadway, Denver, Colo. 80210), New York Coliseum, New York, June 25-27.

Centrex vs. PBX: New Directions, The Eastern Management Group (4 Century Dr., Parsippany, N.J. 07054), Plaza Hotel, New York, June 26-27.

International Conference on CAD/CAM/CAE for Industrial Progress, Computer Society of India and International Federation for Information Processing (Prof. D.K. Subramanian, School of Automation, Indian Institute of Science, Bangalore-560 012, India), School of Automation, Bangalore, June 29-30.

Seminars

X.25 and Packet-Switched Networks, *Data Communications* (McGraw-Hill Inc., 1221 Avenue of the Americas, New York, N.Y. 10020), McGraw-Hill Building, New York, June 17-19.

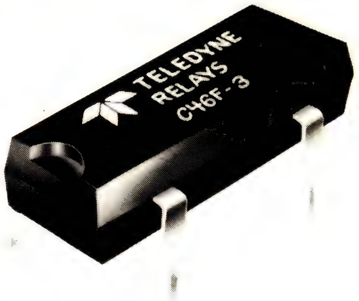
Practical Integrated Circuit Fabrication, Integrated Circuit Engineering Corp. (15022 N. 75th St., Scottsdale, Ariz. 85260), Marriot Hotel, Bethesda, Md., June 17-19.

Machine Vision in Manufacturing: A Hands-On Clinic, Machine Vision Association of the Society of Manufacturing Engineers (Joanne Rogers, SME Special Programs Department, 1 SME Dr., Dearborn, Mich. 48121), Hyatt Regency, Los Angeles, June 17-19.

Knowledge Acquisition for Expert Systems: An Applications Perspective on Planning and Developing the Prototype, Expert Knowledge Systems Inc. (M. James Naughton, EKS, 6313 Old Chesterbrook Rd., McLean, Va. 22101), Embassy Suites, Tyson's Corner, Va., June 17-21.

Electrical Safety Practice: Product Design and Management, MIRA Corp. (Mark Rand, MIRA Corp., 2301 Glenheath Dr., Kettering, Ohio 45440), Anaheim Marriott Hotel, Anaheim, Calif., June 18-20.

Rotating Machinery—Vibration Analysis and Diagnostic Techniques, Mechanical Technology Inc. *et al* (MT/SR, 968 Albany-Shaker Rd., Latham, N.Y. 12110), Century House, Albany, N.Y., June 18-21.



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INDUSTRY'S VERDICT:

A GOOD YEAR AHEAD

UP FRONT

Hitachi goes commercial with fast bipolar-CMOS process

Eager to get its high-speed, low-power bipolar CMOS process to market, Hitachi Ltd. has announced a 64-K static random-access memory that it claims has a 25-ns access time, twice as fast as anything available in CMOS. Each memory cell uses CMOS logic and a combination CMOS-bipolar output driver and receiver to attain the fast access at 300-mW power levels [*ElectronicsWeek,* Nov. 5, 1984, p. 17]. The chip, the H6787, won't be in sample quantities until August; Hitachi unveiled it at a Tokyo trade show last week to test the waters. A spokesman says the process will be the basis of its venture into the gate-array market. Hitachi is adding two fab lines at its Takasaki plant to make bipolar-CMOS chips. Hitachi also announced one-time programmable versions of its 6300 family of 8-bit microcontrollers. Expected to be priced at about one third that of ultraviolet-reprogrammable parts, the chips give designers a low-cost way of getting into quick "zero-turnaround-time" production while waiting for masks to be developed for a full-production ROM. ☐

Thomson-CSF has 68020 second-sourcing rights, Motorola decides

A series of legal correspondence between attorneys at Thomson-CSF and Motorola Inc. has cleared the air over whether or not the French firm has secured second-sourcing rights to Motorola's 32-bit 68020 microprocessor: it has. Thomson thus becomes the first 68000-family sourcing partner to own the much-sought-after manufacturing rights. The other 68000 sourcing partners—such as Signetics, Mostek, and Hitachi—are still negotiating with Motorola, which continues to seek equal technology in return. Confusion set in early this year when microprocessor division officials in Austin, Texas, insisted that a pact with Thomson was similar to other 68000 alternate-sourcing contracts, with both companies agreeing only to negotiate for 68020 manufacturing rights. Thomson attorneys then rifled off a round of letters to Motorola officials in Geneva, questioning press reports that product officials in Texas claimed no 68020 agreement had been set. As yet, no technology-transfer timetable has been established between Motorola and Thomson. ☐

Computervision brings out new system to link work stations with hosts

Computervision Corp., a pioneer in the computer-aided design and -manufacturing marketplace whose financial woes recently caused it to lay off nearly 1,000 workers, is trying hard to get back on a growth track. This week it announced a network linking its host-based systems with intelligent work stations. Called the CDS II, the offering is part of Computervision's transition from host-based systems to networked work stations in an open architecture. At the end of 1984, the company introduced intelligent work stations, developed jointly with Sun Microsystems Inc., Mountain View, Calif. The network is an Ethernet-based system that can link the work stations with Computervision minicomputer hosts or with Digital Equipment Corp. VAX machines. The configuration will allow work-station end users to work interactively with application software running on the minicomputers. ☐

Motorola shelves speech-synthesis chip

Motorola Inc. will be talking less about synthetic speech in the coming months after management decided recently to shelve a unique chip product incorporating two asynchronous central-processor blocks on the same die [*ElectronicsWeek,* Aug. 27, 1984, p. 17]. In what it called a difficult decision to reallocate resources to other product areas, Motorola says the MC6187 and its speech-development system are on hold. But they could resurface again once the semiconductor markets improve. ☐

UP FRONT

Zenith's new line of TV sets features multichannel television sound

Multichannel television sound (MTS) is being used increasingly in the U.S., with more than 200 TV stations expected to be broadcasting in stereo by year end. One of the latest confirmations of this trend comes from Zenith Electronics Corp. The company late last week unveiled its 1986 product line, which includes 14 color-TV models equipped with built-in MTS circuitry for receiving stereo and bilingual TV broadcasts. The new stereo-equipped offerings include a 45-in.-diagonal projection unit as well as seven models equipped with Zenith's new 27-in. diagonal square-cornered tube. The 30 other models in the new Zenith color-TV line can all be adapted for stereo. Zenith also introduced four new video cassette recorders, including one VHS high-fidelity unit with a built-in MTS tuner for playback and recording of stereo broadcasts off the air. Other Zenith entries include the firm's first front-projection TV unit. That system is designed to project an 8-ft. diagonal picture on a wall or screen from a distance of 10 ft. ☐

Masscomp field upgrades boost performances 200% to 300%

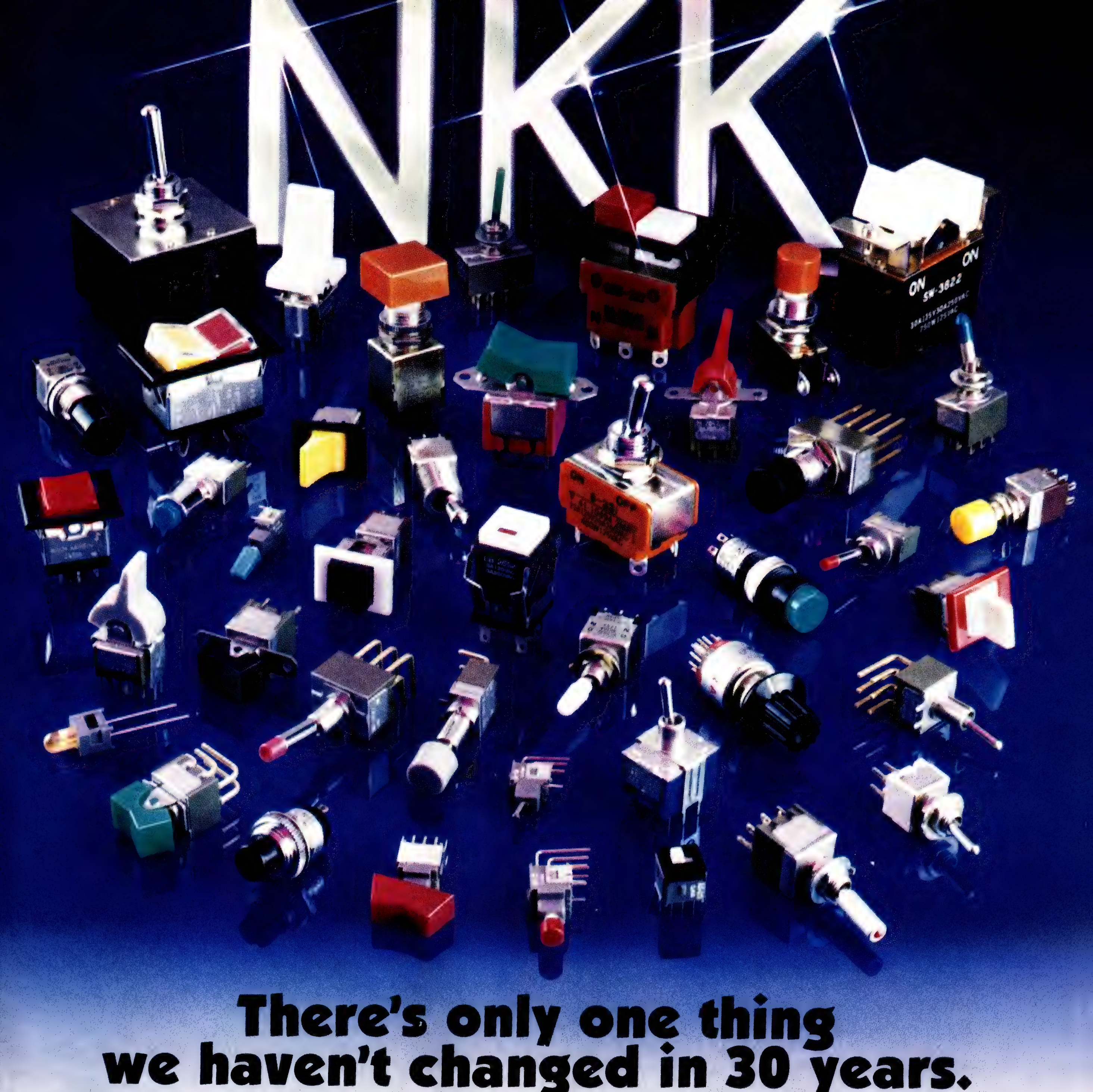
Masscomp will announce today two field-upgrade packages designed around Motorola Inc.'s 16-MHz 68020-based central processing units that boost the performance of Masscomp's 500 series computer and work station systems by two to three times. One package contains the new CPU plus 2 megabytes of memory, a 32-bit memory-interconnect bus optimized for the 68020, and a floating-point-processing chip. The second upgrade package adds a board-level floating-point processor. The upgrades, which won't be ready until the first half of next year, increase the 500 series system performance when running the standard Whetstone single-precision floating-point Fortran benchmarks to more than 650,000 Whetstones and over 2 million Whetstones, respectively. ☐

Europe nudges OSI bandwagon with test-center plan

European efforts to promote open-systems interconnection reference model are starting to make some progress. The European Community has issued a call for proposals to establish test centers before year end to validate networking software conforming to the OSI model. Britain's National Computing Center is already set to validate layers three and four of the OSI model, using as a basis techniques developed by the U.S. National Bureau of Standards. Also in Britain, efforts to "intercept" standards ahead of official ratification are paying off. One small British software startup, LDR Systems Ltd., has come up with a portable networking package that is said to be the first-ever independent implementation of these standards. Written in Pascal, with versions in C, the package, called Isonet, has been implemented on IBM's PC, Burroughs' B-20, DEC's VAX, and ACT's Apricot. ☐

GE deploys more custom IC troops

General Electric Co.'s Custom Integrated Circuit Department last week opened a design center in San Jose, Calif., the third of seven such centers it plans to have in operation this year. GE offers customers the use of work station and mainframe computer-aided design equipment and software in designing circuits from GE's 2-micron-cell library. Like Waferscale Integration Inc. and LSI Logic Inc., GE has built its library around a CMOS version of the popular 2901 series of bipolar bit-slice microprocessors. GE also operates through two third-party design centers and shares space with other custom houses at five distributor centers run by Schweber Electronics. It builds customer-designed chips in its Research Triangle Park, N.C., facility. ☐



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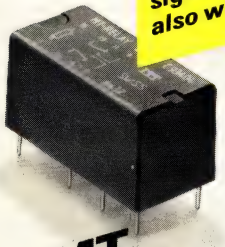

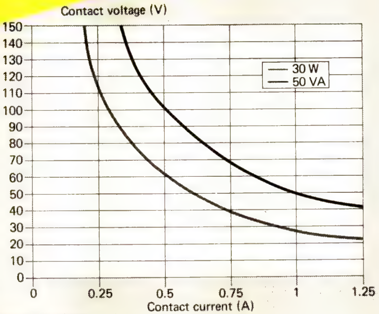

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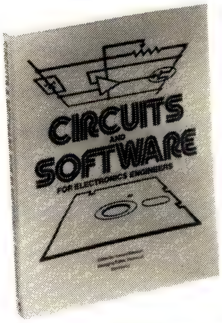

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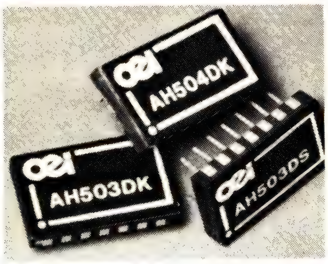

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THIS ElectronicsWeek

THURSDAY *May 9*

As the sagging U.S. computer market showed no signs of renewed vigor at home, **Tandy Corp. and Sperry Corp. looked south to Mexico in search of new markets for their personal computer products.** Tandy said it will build its Model 1000 personal computers at a Computadoras y Asesoramiento S.A. (CYASA) plant in Mexico City, constructing the monitors entirely of Mexican components. Sperry, which said in April it plans to build a personal computer plant in Brisbane, Australia, will permit Microsistemas Micron S.A. of Irapuato, Mexico, to manufacture personal computers compatible with the Sperry PC. They will be sold under the Sperry label, the company said.

FRIDAY *May 10*

A tale of high-technology intrigue began to unravel today when **British authorities arrested and held without bail a West German man on U.S. charges of illegally exporting high-tech equipment to East Germany and the Soviet Union.** In a 60-count indictment, Werner Bruckhausen is accused of violating the federal export and tax laws. Bruckhausen allegedly smuggled a microwave receiver system, semiconductor-manufacturing equipment, a computer system, and other military and scientific items into the Soviet bloc between 1977 and 1980. The U.S. has until June 23 to provide documentation to support its demand for Bruckhausen's extradition.

MONDAY *May 13*

"What hath God wrought?" Samuel Morse intoned when he sent the first telegraph message in 1844. The now-famous line was used again today in what was claimed to be **the first transatlantic transmission of computer data using cellular-radio telephone links.** Demonstrating The Bridge—a product designed to protect data during transmission over mobile cellular radio—Spectrum Cellular Corp. staged the event from a moving Winnebago van in front of the Dallas Infomart. The message had to traverse a difficult path: beginning in a battery-backed portable computer, it passed through The Bridge to a Dallas cell site, across a land telephone line, up to a satellite, back down to a land line in England, and finally to a cellular site where it was broadcast to the London office of Intelligence UK Ltd., which plans to market the Spectrum product in Britain.

TUESDAY *May 14*

Wall Street investors continued to lose confidence in the semiconductor and computer industries. Texas Instruments Inc., which less than a month ago was trading for more than $110 a share, led the decline among chip makers, dropping $2.50 to $92. The day's other losers: Advanced Micro Devices, Motorola, Intel, and National Semiconductor. Computer makers fared no better: IBM Corp. fell $2.25 to $128, leading the way for Digital Equipment, Data General, Honeywell, Burroughs, NCR, and Kaypro to suffer similar nose-dives.

WEDNESDAY *May 15*

Allied Corp. agreed to buy the Signal Companies Inc. for nearly $5 billion in cash and stock. Their boards agreed to form a new company—Allied Signal—which would be one of the world's largest technology firms. Allied said the agreement precludes any bid to acquire Hughes Aircraft Co., a move that both companies were considering. Combined electronics-related sales exceeded $3 billion out of a total of about $17 billion in 1984. □

SLUMP STILL PLAGUES U.S. SEMICONDUCTOR MARKET

Inventory overhang persists, forcing forecasters to lower their earlier estimates for 1985

San Jose, Calif.

Another woeful month of low semiconductor billings has seriously weakened the hypothesis that the industry is only temporarily stalled by an inventory correction. "The inventory should have been gone by April," said Semiconductor Industry Association president Thomas D. Hinkelman last week, after preliminary figures showed that the April book-to-bill ratio had dropped back to 0.77.

It was the eighth straight month that the figure had been below 1.00 (see chart, p. 19). This consistently low performance had been laid to huge inventories built up during a banner year in 1984, but Hinkelman says that force is no longer operating. "We should be seeing buying in some product sectors but the demand isn't there," he noted.

Forlorn forecast. Only a week before, the World Semiconductor Trade Statistics program, an industry committee backed by the SIA, the European Electronic Component Manufacturers Association, and the Electronic Industries Association of Japan, cut its rosy forecast of a 21% gain for U.S. semiconductor sales this year to a 13.5% loss, to $10 billion.

The SIA went even further: it is now predicting a drop of more than 20% in sales, to $9.2 billion this year (see chart below). It estimates billings for the first half of 1985 at $4.4 billion to $4.5 billion.

Average monthly orders for the three-month period ending in April were $580.2 million. Not since the third quarter of 1983 have shipment levels run as low as those for the current quarter, says SIA analyst Mike Kubiak. "Between the third quarter of 1984 and the second quarter of 1985, business lost a billion dollars a quarter in the U.S. market alone," he says.

Blame it on computers. Kubiak saw a glimmer of hope in the fact that Commerce Department figures show an upturn in computer and office-equipment orders of 14% between January and March. Weakness in these areas gets the primary blame for the semiconductor slump.

In the light of the Commerce Department figures, Kubiak hopes for a moderate (meaning under 5%) increase in sales in the third quarter of this year, and a bigger increase in the fourth quarter as inventories are finally brought under control.

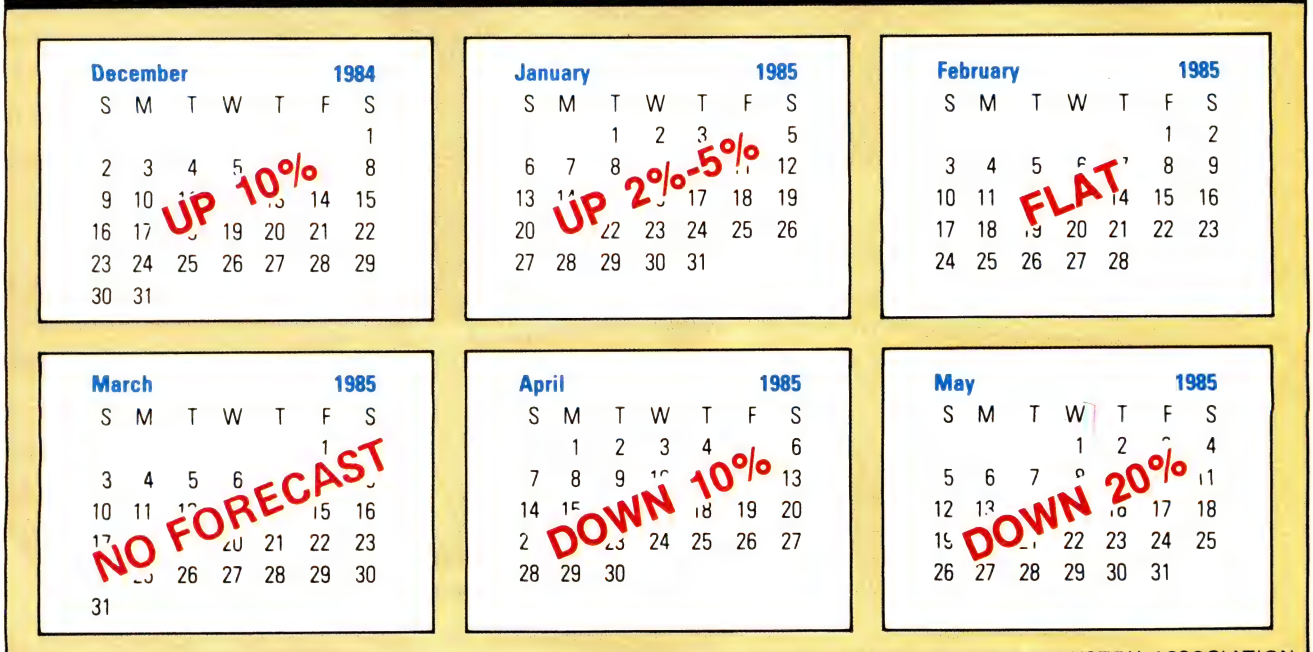
The WSTS, which last September had visions of a 26% gain in worldwide semiconductor sales, now forecasts a 4.3% drop to $24.8 billion. But only the U.S. sector of the market is actually seen as a loser.

Looking abroad. Europe and Japan may chalk up modest increases of 9% and 2%, respectively. In Europe, Kubiak explains, markets are still new and the penetration level is low. Nevertheless, he thinks Europe will do well to gain 5%. The Japanese market, he continues, is supported by large sales in the consumer market.

The WSTS continues to forecast gains for 1986 and 1987, bringing total sales of integrated circuits to $27.8 billion by the end of 1987. That's down 23% from its forecast of last September. Kubiak also sees a recovery in 1986, but says that, "My window has been pushed back six months."

Not everyone is sanguine about recovery in the U.S. market this year. "The primary market for semiconductor

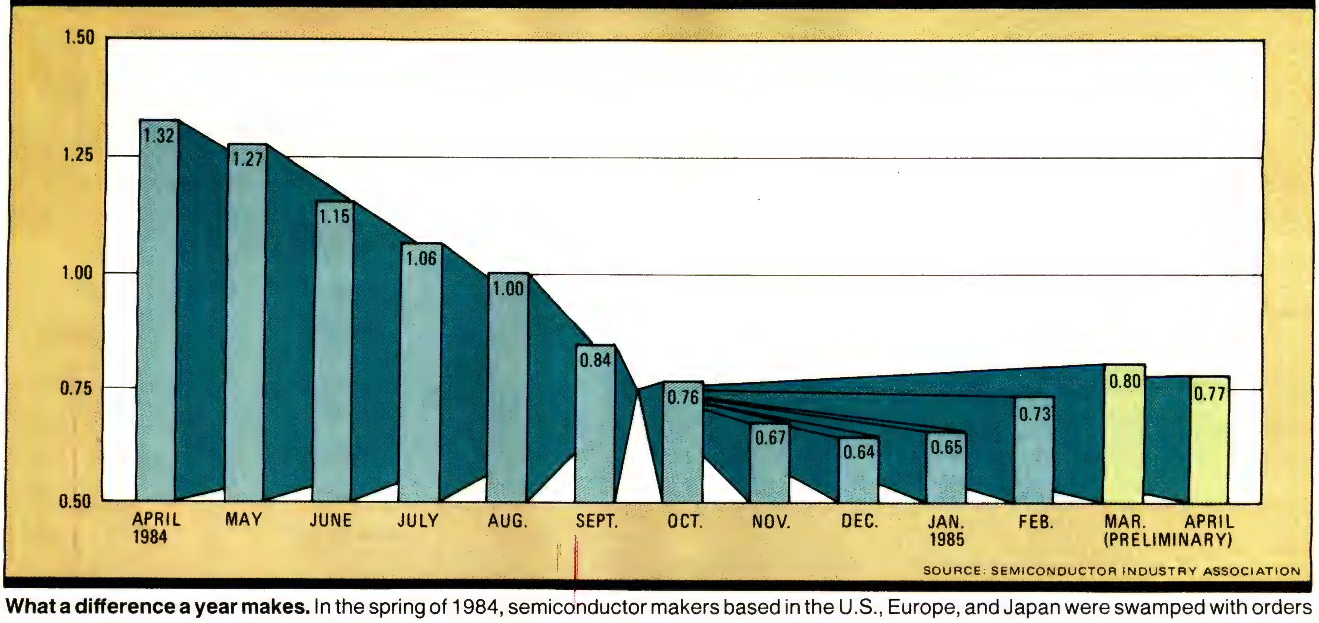
SEMICONDUCTOR SLUMP: HOW SIA REVISED ITS '85 FORECAST



SOURCE: SEMICONDUCTOR INDUSTRY ASSOCIATION

Down, down, down. Ever since the SIA forecast last December that 1985 semiconductor markets would rise "about 10%" to reach a level of $13 billion, it has been revising its estimate downward. The latest fix projects a drop of 20% or more and a market no higher than $9.2 billion.

BOOK-TO-BILL RATIO OF SEMICONDUCTOR COMPANIES BASED IN U.S., JAPAN, AND EUROPE



SOURCE: SEMICONDUCTOR INDUSTRY ASSOCIATION

What a difference a year makes. In the spring of 1984, semiconductor makers based in the U.S., Europe, and Japan were swamped with orders that pushed the book-to-bill ratio to near-record levels. The ratio dipped below 1.0 last September and has not yet climbed back.

growth in the United States is based on computers and peripherals; and most of the computer and peripheral manufacturers are starting to go offshore," notes Dean Winkelmann, an analyst for Integrated Circuit Engineering Corp. in Scottsdale, Ariz.

"Any growth supplied by these industries will show up overseas," Winkelmann concludes. "It's really starting to catch up with us as far as IC consumption is concerned."

Dilution of these segments means that "the automotive industry and the military will have to hold up the market," Winkelmann says. "And these areas aren't a large enough marketing segment to offset what we are experiencing in the computer area," he says, particularly since the economy as a whole has also slowed.

Economy measures. The drop in billings is squeezing semiconductor companies into layoffs and economy measures designed to protect their enormous investment in research and development and new capital equipment. Last month, Fairchild Camera & Instrument Corp. of Mountain View, Calif., eliminated 280 jobs by closing its digital bipolar logic facility, cut 170 jobs from its analog unit, and announced plans to sell its wafer-fabrication plant.

Signetics Corp. of Santa Clara, Calif., plans to lay off 550 workers in June, in addition to the 400 cut last February. Mostek Corp. cut 2,000 by closing its Colorado Springs plant this month (see story, p. 20). Advanced Micro Devices Inc. of Sunnyvale, Calif., though maintaining a no-layoff policy, is requiring its 8,000 employees to take a mandatory eight-day vacation in late June and July.

AMD will open two new 6-in.-wafer fabrication lines this year, however, even though its current capacity is underutilized. "We have no choice," says James B. Downey, senior vice president of operations. "Short term, the situation is grim. But if we cut back, then when things return to normal, we would not be able to take advantage of our investment in R&D." *–Clifford Barney*

MEMORIES

SAGGING PRICES STING JAPANESE PRODUCERS

Tokyo

The persistent business woes that have sent semiconductor-market forecasters in the U.S. back to their computers and crystal balls for lower estimates almost every month since last December have been felt on the far side of the Pacific as well.

In mid-May, prices for low-end n-MOS 256-K dynamic random-access-memories broke through the 1,000-yen barrier ($4 at the current 250-yen-per-dollar exchange rate) in Japan. Bad prices, like bad news, travel fast. In Tokyo, analysts are convinced the same sort of downward movement will occur shortly in the U.S.

Prices for low-end 256-K DRAMs fell below 1,000 yen in early May

In Japan, 256-K DRAMs in plastic packages rated at 150-ns access times currently go for around $3.40. That works out to a precipitous 70% drop over the last six months. Half a year ago, the same memory chips were selling for around $12.

Even for an industry that has learned to stomach fast rides down the learning curve, the new prices come as a shock. "In January 1984, makers were selling 256-K DRAMs for $92," says Richard F. Adler, president of the Corton Trading Co. "Terrible, isn't it?"

The rapid drop in 256-K DRAM pricing came about much faster than most analysts thought, and it signals trouble ahead for the already pinched semiconductor industry. It took the earlier generation of 64-K DRAMS a full year to drop from $12 to $3.60 in Japan.

Saving graces. Some two thirds of the latest generation of memory chips are going into office-automation equipment—mostly personal computers and minicomputers—as Japanese makers gear up to meet the increasing demand from businesses. Minicomputer sales are continuing to grow at about a 25% annual rate this year.

As a result, analysts in Tokyo are quick to point out that only the low-end classes of 256-K DRAMs crashed through the $4 barrier. And they add that not all makers have yet dropped their prices that low. Hitachi, for example, which is currently selling a 256-K n-MOS device for about $4.40, says that its average product price for 256-K parts is hovering around the $9 mark; Hitachi expects, though, that the average will drop to $8 by summer.

Meanwhile, prices for 64-K DRAMs continue their slide, and now hover around 72¢. Hitachi is currently selling a CMOS 64-K DRAM package with 150-ns access time for $1.12 in lot shipments. A slower, 200-ns version of the same product is going for about 80¢. "This is all bad news for semiconductor makers," says an American industry executive in Tokyo. "But the computer and industrial products buyers are in hog heaven."

U.S. presses for cutback. Against this worrisome background, Japanese goverment sources revealed earlier this month that the U.S. government has asked Japan to cut back on its investment in semiconductor production facilities to help relieve some of the pressure that is now facing the depressed U.S. semiconductor industry.

But American firms are not the only ones who will be suffering. NMB Semiconductors Ltd., for example, spent $100 million to set up new production facilities for 256-K DRAMs. The Tokyo firm thought it could get to market this spring with a CMOS product selling for approximately $11, a price that it figures would give it a fair return on its investment. Instead, company officials say, they have been forced to slash the price to $5.50, even before beginning shipments. *–Jonathan Joseph*

SEMICONDUCTORS

WOEFUL MOSTEK PONDERS FUTURE

Carrollton, Texas

Battered by the rising and falling waves of demand for its memory products and weighed down by growing levels of red ink, officials of Mostek Corp. face the challenge of trying to keep the corporate ship afloat as they try to make for more profitable waters.

One of the main components of this new course involves building a highly automated wafer front-end processing facility in Carrollton. Plans for the project still under way—at least on paper. Designed to use robots and eliminate intervention by humans, the totally automated 6-in.-wafer-processing facility is scheduled to be operational by 1987. Development work has been under way since 1983 with the blessings of Mostek's parent, United Technologies Corp.

Mostek's approach to ultraclean fabs of the future calls for a special building with robotic wafer-moving and -processing equipment housed inside tunnels. The tunnels will have Class-1 clean room atmospheres (less than 100 particles of dirt measuring 0.5 μm or less per ft^3 of air). The project is aimed at automating chip processing of part geometries approaching 1-μm—feature sizes necessary for 1-Mb memories and next-generation 32-bit microprocessors.

Despite the recent shutdown of Mostek's four-year-old Colorado Springs plant and the loss of 2,000 jobs [*ElectronicsWeek*, May 13, p. 13], a spokesman says the robotic front-end is still very much alive. But it is now under review by a task force recently created to stem the company's losses.

United Technologies sent senior vice president Richard Gamble from its Control Group to head cost-cutting efforts in Carrollton. Mostek executives have been shuffled in an attempt to streamline management.

Industry observers say the shakeup and reorganization not only clouds Mostek's future role with United Technologies, but also strengthens their belief that major defense aerospace firms should not be in the commodity chip business. Chip operations should be adjuncts to defense companies' mainstream operations, analysts think.

Hooked. A new move to diversify, launched by president Harold L. Ergott Jr., has not helped Mostek kick its DRAM dependence.

Almost a year after the 1979 purchase of highly profitable Mostek for $345 million, losses began to plague the MOS supplier despite attempts to ease its heavy dependence on dynamic random-access-memory markets. Mostek lost $150 million in 1981 and $70 million in 1982, according to industry estimates.

Off course. Ironically, a jump in DRAM profitability during chip shortages in 1983 and early 1984 sidetracked Mostek's attempts to diversify as memory-chip operations raced to fill the unmet demand, say former managers.

With industry capacity growing and personal computer markets slowing, Mostek president Harold L. Ergott Jr. a year ago launched his own restructuring effort to pump new life into the stalled diversification drive. A new Diversified Products Group was created to boost the growth of its semicustom gate arrays, standard cell products, microprocessors, communications integrated circuits, and military components.

Still caught in what some former and current Mostek managers agree is a "DRAM trap," the MOS house found 65% of its business coming from commodity memory markets when the steep slump began late last summer. Worries about falling fabrication yields and efficiencies prevented the introduction of new products on processing lines filled with 64-K chips, some now complain.

To make matters worse, Mostek's 32-K-by-8-bit 256-K DRAM is nearly 18 months late in reaching volume production. Touted in August 1983 as the industry's first byte-wide DRAM, the MK4856 is still in the sampling stage.

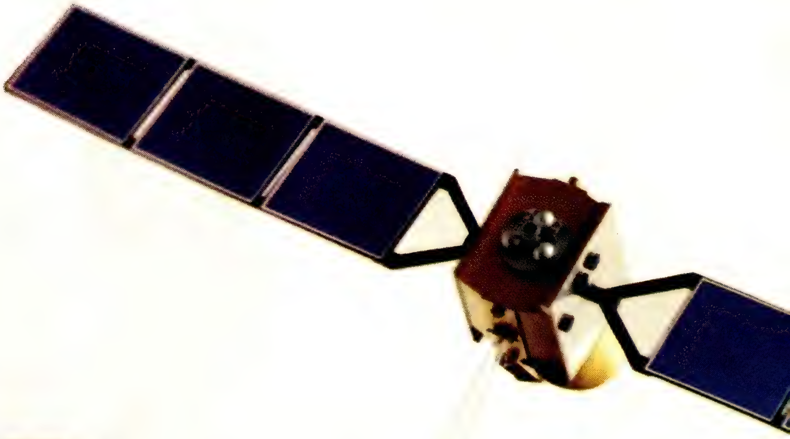
Hopes for a turnaround this year now hinge on a series of new products, including an Ethernet local-area network chip set, new CMOS gate arrays with double-level programming metal, and the MK3901M, a 1-Mb read-only memory chip featuring a by-16-bit word-wide bandwidth that is suited to 16-bit microprocessors.

Despite losses and layoffs, Mostek still plans a new fab plant

Mostek executives recently told a meeting of security analysts at United Technologies' headquarters that Mostek lost $40 million in the first quarter of 1985. Analysts expect a similar loss in the current quarter. But they believe the loss rate is likely to slow in the second half, resulting from the shutdown of Mostek's Colorado Springs plant and the layoffs.

United Technologies is reportedly interested in selling the plant, which has been used almost exclusively to make n-MOS 64-K DRAMs. However, Mostek officials decline to comment on the

SIEMENS



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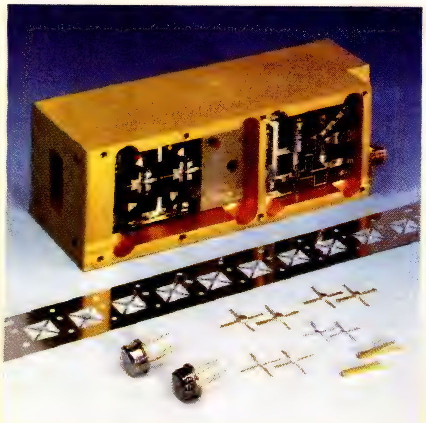

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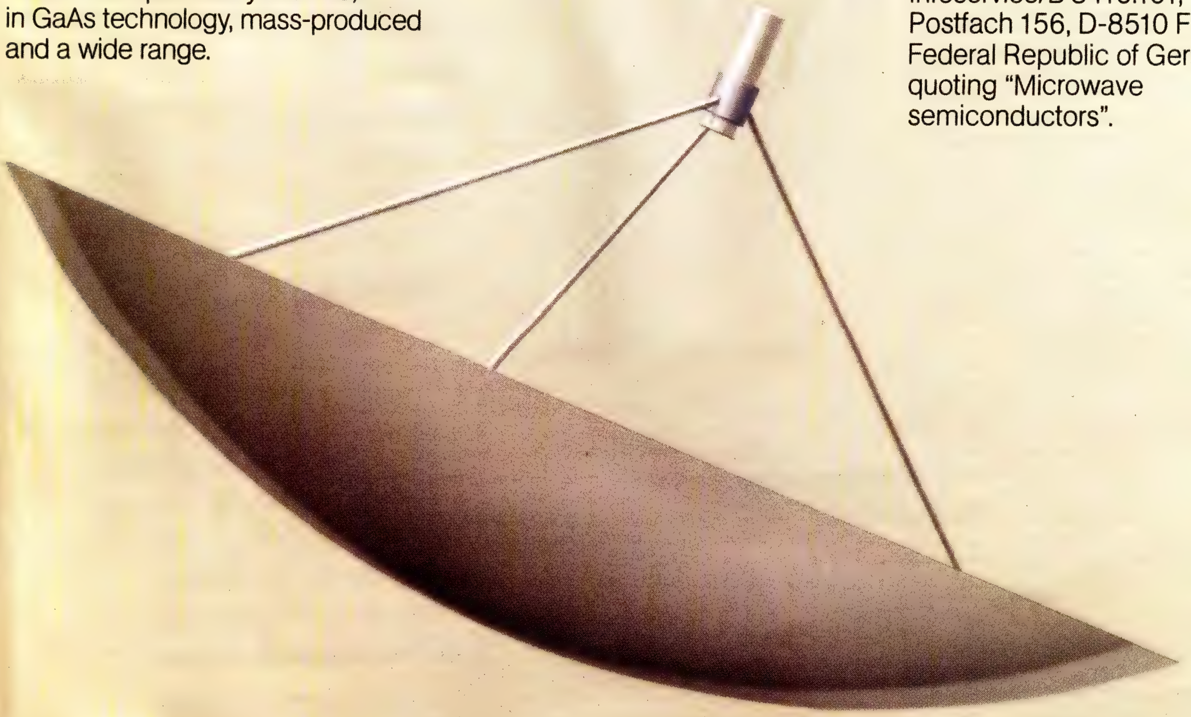

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M 1000 A1	1	1080	64	62	24
M 1500 A1	1	1458	74	72	24
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B 500 A1	2	500	64	28	1.2	ECL/TTL	HBIP 1	1.2
B 1000 A1	2	1000	84	38	1.8	ECL/TTL	HBIP 1	1.2
B 1200 A2	2	1200	84	72	1.1	ECL/TTL	HBIP 2	0.8
B 1700 A2	2	1700	100	88	1.7	ECL/TTL	HBIP 2	0.8

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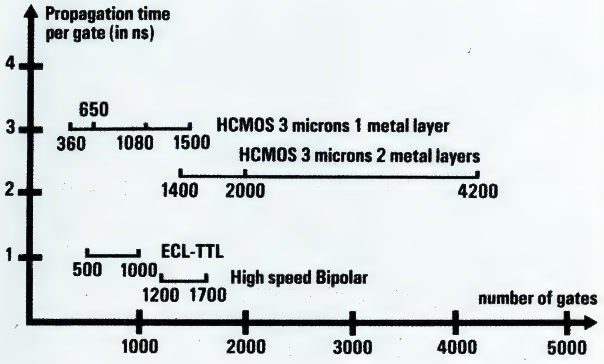

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plant's status.

"There is certainly no sense any more in paying a premium for the goodwill [of a chip merchant], or for that matter even being in the commodity business at all," says Joseph Campbell, an aerospace analyst with Paine Webber Mitchell Hutchins Inc. in New York. "All major defense companies have silicon foundries of some kind—Martin Marietta and McDonnell Douglas do. But they are getting closer to the silicon technology through R&D investments—starting around $100 million—as opposed to an acquisition of a commodity semiconductor vendor," he says.

"Mostek lost $150 million in 1981—and considering the size of UTC, it is not at all farfetched to say United Technologies thinks of it as R&D," adds Campbell, noting that the $15.48 billion conglomerate has earmarked over $1 billion for corporate R&D. "So I think they are inclined to let [Mostek] run along if it can piece things back together... However, I think they will reconsider the issue later, but not this year with the numbers being so bad and the market weak." *–J. Robert Lineback*

MILITARY

IBM-NAVY SPAT CONTINUES OVER SUBACS CONTRACT

Washington

A dispute over cost overruns on the Navy's Submarine Advanced Combat System, or Subacs, continued to simmer last week, with the Navy and prime contractor IBM Corp. disagreeing over the amount of the overrun and the quality and timeliness of the work completed thus far.

Though the Navy reportedly estimates cost overruns totaling as much as $800 million on the $1.7 billion contract, Norm Koestline, a spokesman for IBM's Federal Systems Division in Bethesda, Md., says the figure is much lower. Based on current IBM projections, the overrun total is less than $100 million through completion of the contract, Koestline claims.

IBM is currently under contract to improve sonar, navigation, and weapons-control systems for nine 688-class attack submarines the Navy now uses. Previous reports put the total at 21.

No overruns. Lt. Max Allen, a Navy spokesman at the Pentagon, says only that, "In the Subacs program, there have been future overruns projected. However, this project will be [completed] within budget and will be structured to do so." Although he declined to discuss specifics, Allen did say that requests for proposals for two additional Subacs phases went out to potential bidders on April 18 and "a decision will be made sometime this summer."

These phases involve the development of a computer system for the Navy's next generation of submarines, the SSN-21. Current IBM subcontractors for Subacs are expected to be among the bidders for those contracts.

To date, Koestline says IBM has received $1.2 billion for the basic phase of the contract. He says IBM will install an array of sensors and weapons systems in the present generation of submarines by May 1987. These submarines are equipped with computers manufactured by Sperry Corp. "The Subacs-Basic program is intended to tie together sonar and fire control and to improve the acoustical capability of the subs," he explains.

Citing security reasons, Koestline declined to comment specifically concerning allegations of insufficient memory capacity in the integrated circuits produced by IBM, saying only that "we have met the technical standards so far." *–George Leopold*

COMPUTER-AIDED DESIGN

SILICON COMPILERS CATER TO IC EXPERTS, NOVICES

New York

In the game of technology leapfrog between circuit designers and chip-fabrication experts, the chip makers for the moment are in the lead. Although they can turn out chips of incredible complexity, producing designs that fully exploit such extensive integration is nearly impossible.

The next leap of integrated-circuit technology, however, should bring the circuit designers abreast of the chip makers. Silicon compilers, software packages that produce complete and validated digital integrated-circuit designs from functional specifications, have started to catch on.

Available commercially only since last October, the compilers have been heralded as a way to do away with the IC-design bottleneck, and silicon foundries are pressing to get them into service. Compilers that can do analog circuits are emerging, and a second-generation product that compiles other silicon compilers will debut this week.

Silicon compilers should bring IC designers abreast of chip makers

The second-generation package is the handiwork of Silicon Design Labs Inc. The Liberty Corner, N.J., firm is unveiling its Generator Development Tools this week at the Custom Integrated Circuits Conference in Portland, Ore.

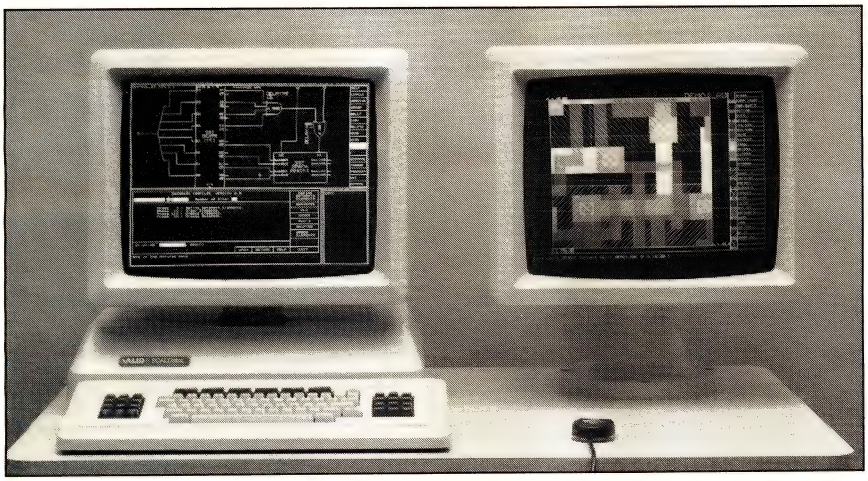
Silicon Design Labs' president Dick Gossen describes it as a coordinated set of tools that automate the silicon-compiler building process. "GDT is not a set of specific silicon compilers that express the design efforts of the IC designers who built them, like the silicon compilers currently on the market," says Gossen. "Rather, it is a software product for IC designers to capture their design expertise." The capture is made in the form of generators or cell compilers with variables that system design users can change to tailor the final circuits.

"We hope to spread silicon-compiler technology more widely throughout the electronics industry," says Hal G. Alles, vice president of custom engineering at Silicon Design Labs. "Everyone with [IC design] expertise should have access to silicon-compiler technology."

With GDT, circuits are represented in a single parameterized information base. From this, a circuit can be manipulated in many forms, such as chip-layout geometry, schematic diagram, or as a description in GDT's special circuit language.

Analog too. The system can build silicon compilers for any mask-defined IC technology, including CMOS, n-MOS, and bipolar. Even analog-circuit module generators can be developed. However, the built-in simulator would have to be modified to do analog simulation. Although this may be done in the future, the open architecture of the GDT system permits an interface that is as easy with outside analog simulators as it is with external digital simulators. In addition, GDT has a bidirectional interface through the GDS-II industry standard circuit-description language to outside circuit-layout tools.

Although Silicon Design Labs announced that its GDT could build analog-circuit generators, the first silicon compiler with an *analog compiler set* will be introduced by Seattle Silicon Technology Inc., of Bellevue, Wash. at the Design Automation Conference in Las Vegas, June 23 to 27. This set will include analog-to-digital converters and digital-to-analog converters, analog switches and multiplexers, operational



Double feature. Seattle Silicon's compiler increases productivity of IC designers by displaying the circuit schematic on one screen and the corresponding chip layout on another.

amplifiers and comparators, components (such as diodes, resistors, capacitors, and FETs), and a Pierce oscillator.

Seattle Silicon's Concorde VLSI Compiler, introduced first on Valid Logic Inc.'s Scaldstar work station, will be made available on the Tektronix Inc. CAE2000 and Mentor Graphics Corp. Idea Series work stations. The company offers its prototype fabrication service in four CMOS technologies: single-layer metal, 3-μm poly width, p well, and a 3-μm double-layer metal rule, which is just being introduced. The Concorde compiler CMOS designs are supported by the leading foundries—Gould AMI Semiconductors, International Microelectronics Products, NCR Microelectronics, VLSI Technology, and Comdial.

Foundry support. Another vendor of silicon compilers since October, Silicon Compilers Inc., Los Gatos, Calif., announced last week that its Genesil Silicon Development System will be supported by four of the same foundries: Gould AMI, International Microelectronics Products, NCR, and VLSI Technology. Under the agreements with the foundries, the Genesil System will support designs in advanced dual-layer metal CMOS or single-layer metal n-MOS with 3- and 2-μm geometries. The Genesil System is supported on VAX-11/750 superminicomputer systems.

Experience counts. Whereas Silicon Compilers and Seattle Silicon direct their products to system designers who have little if any IC-design experience, Silicon Design Labs is offering its GDT product primarily for the experienced IC designers. Seattle Silicon, however, is licensing its compiler development system on a contract-service basis. Experienced IC designers can contract to use Seattle Silicon's language and methodology to create their own compilers to add to those available in the company's Concorde VLSI Compiler set.

However, silicon compilers can be used by those who are not expert IC designers. Both firms address these users. But semiconductor companies using GDT could also make their proprietary compilers available to select customers. The silicon-compiler business could heat up by summer. *–Tom Manuel*

MICROPROCESSORS

DARPA EYES 100-MIPS GaAs CHIP FOR STAR WARS

Palo Alto

For its Star Wars program, the Department of Defense intends to push well beyond the current limits of technology. And along with lasers and particle beams, one piece of hardware it has in mind is a microprocessor chip having as much computing power as 100 of Digital Equipment Corp.'s VAX-11/780 superminicomputers.

One candidate for the role of basic computing engine for the program, officially called the Strategic Defense Initiative [*ElectronicsWeek,* May 13, 1985, p. 28], is a gallium arsenide version of the Mips reduced-instruction-set computer (RISC) developed at Stanford University. Three teams are now working on the processor. And this month, the Defense Advanced Projects Research Agency closed the request-for-proprosal (RFP) process for a 1.25-μm silicon version of the chip.

Last October, Darpa awarded three contracts for a 32-bit GaAs microprocessor and a floating-point coprocessor. One went to McDonnell Douglas Corp., another to a team formed by Texas Instruments Inc. and Control Data Corp., and the third to a team from RCA Corp. and Tektronix Inc. The three are are now working on processes to get useful yields. After a year, the program will be reduced to one or two teams. Darpa's target is to have a 10,000-gate GaAs chip by the beginning of 1988.

If it is as fast as Darpa expects, the chip will be the basic engine for the Advanced Onboard Signal Processor, one of the baseline machines for SDI. "We went after RISC because we needed something small enough to put on GaAs," says Sheldon Karp, principal scientist for strategic technology at Darpa. The agency had been working with the Motorola Inc. 68000 microprocessor, but Motorola wouldn't even consider trying to put the complex 68000 onto GaAs, Karp says.

A natural. The Mips chip, which was originally funded by Darpa, was a natural for GaAs. "We have only 10,000 gates to work with," Karp notes. "And the Mips people had taken every possible step to reduce hardware requirements. There are no hardware interlocks, and only 32 instructions."

The GaAs chip will be clocked at 200 MHz, the silicon at 40 MHz

Even 10,000 gates is big for GaAs; the first phase of the work is intended to make sure that the RISC architecture can be squeezed into that size at respectable yields, Karp says.

Mips was designed by a group under John Hennessey at Stanford. Hennessey, who has worked as a consultant with Darpa on the SDI project, recently took the chip into the private sector by forming Mips Computer Systems of Mountain View, Calif. [*Electronics-Week,* April 29, 1985, p. 36]. Computer-aided-design software came from the Mayo Clinic in Rochester, Minn.

The silicon Mips chip will come from a two-year effort using the 1.25-μm design rules developed for the Very High Speed Integrated Circuit program. (The Darpa chip was not made part of VHSIC in order to open the RFP to contractors outside that program.)

Both the silicon and GaAs microprocessors will be full 32-bit engines sharing 90% of a common instruction core. Pascal and Air Force 1750A compilers will be targeted for the core instruction set, so that all software will be interchangeable.

The GaAs requirement specifies a

clock frequency of 200 MHz and a computation rate of 100 million instructions per second. The silicon chip will be clocked at 40 MHz.

Eventually, the silicon chip must be made radiation-hard; the GaAs chip will be intrinsically rad-hard.

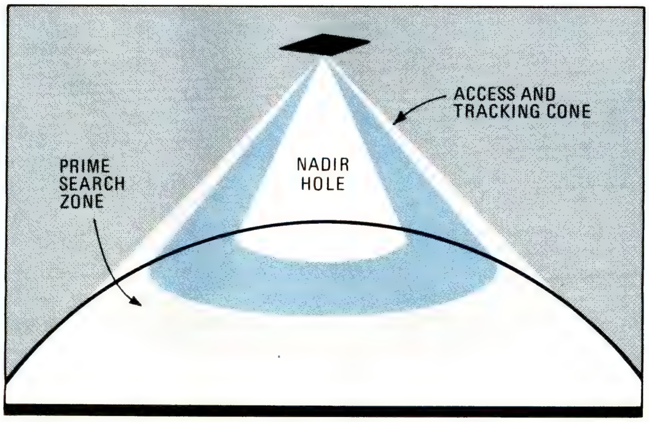
Darpa will not release figures on the size of its RISC effort. The silicon version is being funded through the Air Force's Air Development Center in Rome, N.Y. *–Clifford Barney*

RADAR

RESEARCHERS PROPOSE SATELLITE-BASED ATC

Arlington, Va.

Radar researchers are beginning to look at satellite technology as the air-traffic-control system of the future. Current ATC radar technology is limited to the horizon, and monostatic air surveillance—that is, with transmitter and receiver at the same site—is vulnerable to countermeasures such as jamming. If satellites can overcome these limitations, and space-based radar proves reliable, it could be in commercial and military use by the 1990s, they suggest.



Space radar. A primary advantage of spaceborne radar for air-traffic control is said to be rapid coverage of large areas, such as the heavily traveled North Atlantic routes.

"If the system is up there and data is available, I think its use will be irresistible," asserts William J. Caime, general manager for business development at General Electric Co.'s Space Systems Division in Valley Forge, Pa.

Caime made his comments during an International Radar Conference sponsored by the Institute of Electrical and Electronics Engineers. His paper on space-based radar for intercontinental air-traffic control was one of several touting the advantages of combining satellites and radar. Caime notes that current ATC technology is more than 20 years old and that projected increases in air traffic, especially in the North Atlantic, will outstrip its capacity.

By the year 2000, he estimates, more than 1,200 aircraft will cross the North Atlantic and the Caribbean daily, with as many as 225 aircraft in the air simultaneously during peak traffic periods. Of these, some 80% will be large planes like jumbo jets.

FAA balks. Nevertheless, he concedes that the Federal Aviation Administration, now working on a modernization scheme of its own called the National Airspace Plan [*ElectronicsWeek*, Jan. 7, 1985, p. 12], might not be so hot on space-based radar.

He's right. An FAA spokesman familiar with the satellite proposal says, "It's clearly a very long-term proposition." Integrating space-based radar into the FAA's National Airspace Plan is a complicated question involving cost and reliability, he explains. Although the agency will monitor developments in satellite technology for ATC applications, it will continue to focus on ground-based radar, the official concludes.

Yet Caime details his space-based solution. To provide rapid coverage of large areas such as the North Atlantic (3.75 million square nautical miles), Caime proposes a 45-by-45-meter L-band phased-array radar deployed at an altitude of 3,000 nautical miles (see figure). A 12-satellite system could eliminate global coverage gaps, he asserts.

"Directly derived, real-time images can assist in achieving future goals for more effective control in an environment of increasing air traffic," the GE researcher explains. But the "realization of the full capability of the technique will require continued development of high spacecraft power systems [and] space radar subsystems."

Meanwhile, a spaceborne bistatic radar system proposed by P.K. Lee of Mitre Corp. promises reduced vulnerability to antiradiation missiles, emitter locaters, and directive jammers. Of concern is the need for high-speed signal processing—up to 60 million complex instructions per second, says Lee. He adds, however, that current work within the Navy's Very High Speed Integrated Circuit program may provide signal-processing chips that can meet these needs.

"Really, I'm not too concerned about the speed of processing, because we can [also] do it in parallel," Lee explains. However, he concedes that decentralized signal processing and the need for complex receivers are two disadvantages of bistatic radar systems.

Geostationary orbit. In his paper, Lee proposes a space-based bistatic radar positioned in a geostationary orbit 22,300 miles above the earth. "Satellites in geostationary orbit are more survivable and can obtain location data more easily than satellites in other orbits," he contends. Moreover, he adds, a geostationary orbit would lessen concerns about complex geometry processing and clutter rejection.

The basic configuration would consist of an illuminator in space, and ground or airborne receivers. The number of receivers needed would depend on the area and altitude to be covered.

The major technological challenges of this environment include the need for a power supply of up to 100 kW, a large space-deployable antenna up to 100 ft in diameter with a high-powered amplifier, and a cost-effective means of transporting the system. The Mitre researcher notes that the space shuttle cannot be used for satellite deployment in geostationary orbit.

Instead, he says a large, expendable rocket capable of lofting a 10,000-lb payload is needed. Nevertheless, he contends that "major technological breakthroughs are not required" for deployment in the mid-1990s.*–George Leopold*

OPTOELECTRONICS

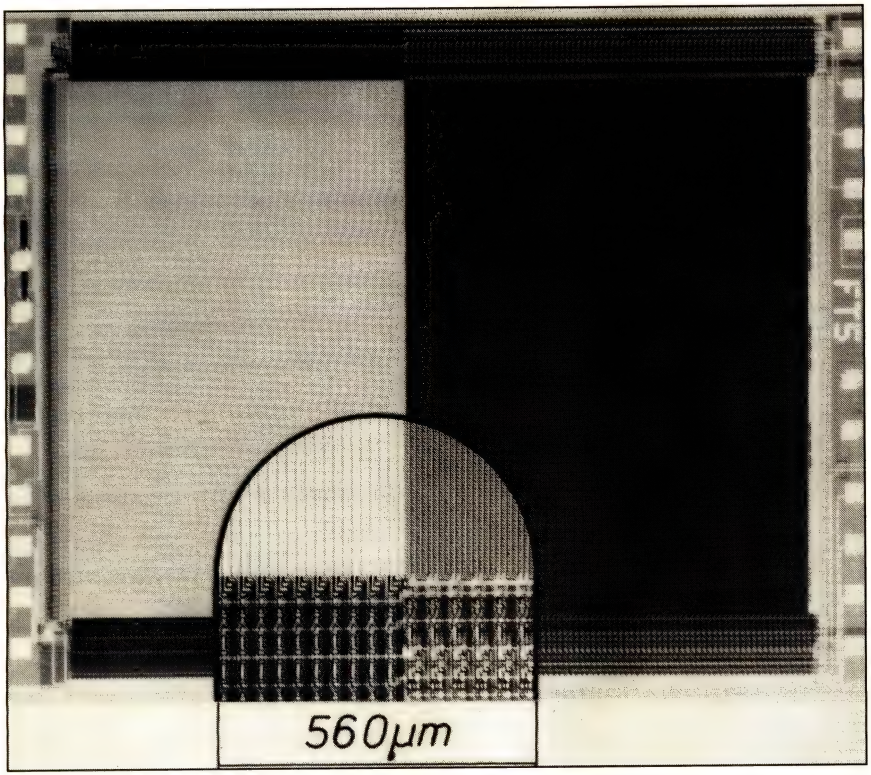
'ACCORDION IMAGER' DOUBLES DENSITY OF CCD SENSOR

Eindhoven, the Netherlands

Drawing on their expertise in charge-coupled devices, which they pioneered in the late 1960s, scientists at the Philips Research Laboratories have developed an image sensor that is likely to have a profound impact on the design of CCD video cameras and other solid-state recording systems.

The development combines a novel storage and read-out principle with CCD and CMOS technology on a single chip to provide what the Dutch researchers have nicknamed "the accordion imager."

The new sensor sports twice the number of light-sensitive pixels per unit area than does a conventional CCD sensor. Significantly, Philips' experts achieved this increase without having to go to a finer electrode pattern on the sensor's



Charging along. In the Philips accordion imager, the image section (dark) and storage section (light) are at the center (the inset shows an enlarged view at the boundary between them). The circuitry for generating the electrode voltages is located along the edges.

surface. A typical experimental device, made with 3.5-μm technology, boasts 355,152 pixels in a 604-by-588-pixel array on a 38.5-mm^2 chip.

The doubled pixel density "permits the design of solid-state cameras either with a higher resolution or of smaller size," asserts Max G. Collet, whose group developed the new device.

Two for four. As Collet explains it, the greater pixel density is achieved by assigning a row of pixels to two electrodes instead of the usual four. This arrangement ordinarily would result in a loss of information when the image information is shifted into the memory, or storage, section. But Philips skirts this shortcoming by means of a new storage and read-out mechanism in which the charge packets representing the information are stretched out one by one and then compressed again like the bellows of an accordion—hence the name accordion imager.

In a conventional CCD image sensor, the width of four electrodes covers a pixel. The light impinging upon the device goes through the polysilicon electrodes and the silicon dioxide insulating material and releases electrons in the n-type channels. These channels are located in a p-type silicon layer and run perpendicularly to the electrodes.

When suitable potentials, typically 0 and 10 V, are applied to the electrodes, the electrons build up charge packets in the n-channels under the positive electrodes. The size of these packets is proportional to the image illumination.

To read out the information from the image section, the electrode potentials are varied so that the charge packets are shifted into the storage section by a transfer mechanism, which is the same as that used in an ordinary CCD. From the storage section, the charge packets are read out line by line to provide the video signal.

In principle, Collet says, the width of two electrodes would be enough to build up and collect the charge packets. But with a two-electrode arrangement, the charge transfer would not be as simple because adjacent packets mix when the two electrodes change their potential. Such mixing would result in loss of information.

This led two Philips researchers to look for another transfer method. Working independently of each other in 1981, Collet and Arnoud J. Boudewijns, then at the Philips video products group, both came up with the new accordion mechanism at virtually the same time.

Instead of transferring all charge packets simultaneously, the new principle relies on temporarily spreading out each packet in the space below two electrodes and separating it by a two-electrode-wide potential barrier. This process—the expansion of the accordion—starts at the bottom edge of the image section. Then the conventional charge-shifting method is used, whereby the image information is read into the storage section line by line.

Squeezed together. The temporary spreading out of the information vanishes, so to speak, when the charge packets reach the bottom edge of the storage section. In this section, then, a row of pixels arranges itself below two electrodes. The accordion is now squeezed together again. The final readout occurs line by line at the bottom edge. This automatically creates the space needed for a new spread-out cycle of the charge packets.

The accordion method not only cuts the pixel dimension from a four-electrode to a two-electrode width, it also reduces the area of the overlap between the electrodes. Further, if the electrode width is reduced, the sensitivity, particularly to the color blue, improves. That is because the less electrode area used, the less light is absorbed and the better the sensitivity. *–John Gosch*

TELECOMMUNICATIONS

BRITISH TELECOM SPREADS ITS WINGS WITH MITEL

London

The international major league of information and telecommunications marketing is about to grow by one more team. If all goes according to plan, the new player will be British Telecom.

Earlier this month, with an aggressive display of entrepreneurial vigor, British Telecom, operator of the UK's telephone network, entered the scramble for a slice of the world information-technology market by buying a controlling interest in Mitel Corp., the Canadian manufacturer of private automatic branch exchanges (PABXs) and regarded as technically superb but financially troubled.

News of the proposed purchase came only days after British Telecom bought CTG Inc., a Toronto-based telephone-interconnect company, for $14.5 million.

If Canadian and UK authorities clear the deal, British Telecom, one of the world's top four network operators with sales of $8.75 billion, will pay $218 million for a 51% stake in the Kanata, Ont., company. Mitel's revenue last year was $275 million.

The move takes British Telecom into two kinds of uncharted waters. First, it will get a manufacturing capability to complement the design talent at its Martlesham research laboratories. It already licenses Mitel's CMOS technology and will now get a modest chip-making plant to go with it. "We regard this as quite a valuable and important part of the acquisition," says Sir George Jefferson, British Telecom's chairman.

Second, and perhaps more significant, the move will put British Telecom in the international marketplace. In its heyday, Mitel expanded rapidly outside Canada, setting up assembly plants in the U.S., the UK, Hong Kong, West Germany, Mexico, and New Zealand. "We intend to build on Mitel's manufacturing and research and development resources in the countries where they now operate, adding a major new dimension to our business," says Jefferson.

Poised for assault. Analysts say the Mitel purchase heralds a major assault on the U.S. market, spearheaded by Mitel's line of digital exchanges: the 2,500-line SX-2000 digital exchange and a digital replacement for the SX-200, a 350-line exchange, scheduled to debut later this year. To succeed, British Telecom will have to regain lost ground. According to one telecommunications market watcher, Mitel's share of the U.S. market has slipped from 14% of lines shipped in 1982 to 6.5% in 1984.

First, though, British Telecom must close out its purchase. Jefferson is confident the deal will go through. "All the advice we are getting is that the approach will be welcomed by the Canadian government," Jefferson says.

In Britain, the Office of Fair Trading will look over the deal and may call in Oftel, the agency that keeps an eye on telecommunications, to advise it. The reason is that the deal poses a threat to British PABX makers such as Plessey Co. plc, which dominates the digital PABX market. Mitel's PABXs, together with two switches of British Telecom design, account for one third of the UK giant's sales. But, says Jefferson, "we do not expect that to change much."

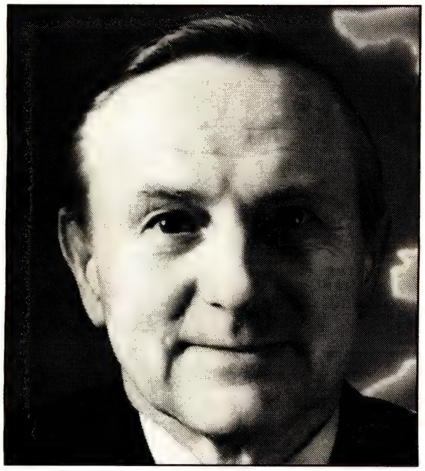
Britain's International Computers Ltd. plc stands to gain from the deal. Because the company has based its office-automation strategy on the Mitel switch, it would benefit by having more switches to hang its gear from.

Converging markets. British Telecom views the purchase of Mitel as part of a long-term strategy to address the converging data- and information-processing markets, a convergence that is being led by the digital PABX.

Mitel was founded in 1971 by two Englishmen, Terry Matthews and Michael Cowpland, both former British Telecom employees, and grew spectacularly until it hit software snags with its first digital exchange, the SX-2000. Later, IBM Corp. backed out of a joint project with Mitel when development costs escalated, reaching $68 million in 1984. All told, Mitel suffered losses of $46 million in the past two years.

But production of the SX-2000 is rolling now, and the 350-line digital version of the SX-200 is in the wings. Says John King, who heads up British Telecom Enterprises, a division of the British firm, "Mitel is all set now to exploit much research and development of the past three years."

Jefferson believes customers have



Outward bound. Sir George Jefferson is piloting British Telecom into the uncharted waters of world marketing with the acquisition of the Canadian PABX maker Mitel.

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be reckoned with, already selling well at $349 (retail price at an IBM Product Center), even if some of the other programs are less than imposing. Other items on the giveaway list are Data Edition, a simplified data-base program; Topview, IBM's windowing environment; and Writing Assistant from Software Publishing Corp.

Buyers of PC/XTs without hard disks are being offered the two members of the Assistant series; models with hard disks come with Displaywrite and a choice of Topview or Data Edition.

Although almost any mainstream software vendor could be threatened to a greater or lesser extent by extensions of IBM's purportedly temporary foray into the free software business, publishers of word-processing software are looking at the most immediate threat. "We raised hell about IBM's move at Comdex," says Peter Pirner, president of Lifetree Software Inc., which sells a successful package called Volkswriter Deluxe. "Every third-party guy I talked to was pretty upset about it."

IBM says it's just a promotion; software houses are upset

Another firm with word-processing revenues to lose is Multimate International Corp. Its Multimate program sells for $495 and is currently near the top of the corporate bestseller lists. IBM would be shortsighted, in the opinion of Multimate chief executive officer Richard Lefebzre, to use free-software tactics widely, as independent software products were key factors in IBM's personal computer market penetration.

"Anytime anyone gives something away for free, it becomes more difficult for us to sell our product," says Donald Marro, vice president of marketing for Micropro International. Micropro's Wordstar was adapted to the IBM PC at a time when the machine still had almost no software to run.

"It tends to devalue software," agrees John Day, vice president of corporate communications for Samna Corp., another word-processor software vendor. "It makes it harder for a dealer to sell software at list price."

Inventory problem. Asked about the IBM move, Marro commented, "The facetious answer is that it makes you pine for days when there was a robust Federal Trade Commission. The serious answer is different—IBM is faced with an inventory situation it needs to get out from under. It's taking a position anyone in the same boat would take to get some momentum going.

"But the key person in this is neither IBM nor us, but the dealer," Marro continues. "This situation takes away some of his flexibility. He loses in terms of profitability: he can make more money selling something than he can by giving it away."

Software companies, however, stand directly in the line of fire. Legal action reminiscent of earlier bundling battles in the mainframe arena may be on their minds, but as yet none has chosen to challenge the giant computer maker's army of lawyers.

"I think we should wait and see," says Marro. Litigation of this type "has happened in the past when IBM used its size and resources to foreclose opportunities for others. Litigation is always the path those disadvantaged have taken, and they sometimes prevailed."

Developers of microcomputer software, whether or not they choose to load the guns of legal war, will no doubt lean on the industry's principal strength—its entrepreneurial nimbleness. "Software companies thrive on coming up with better solutions," points out an unworried Patrick Comeaux, president of Parameter Driven Software Inc. "People will continue to go after software that they feel the most comfortable with and that gives them the best solutions."

Problem downplayed. Still, at least one industry observer downplays the effect of IBM's software giveaway program on other software vendors. "There is no danger that IBM will take over the personal computer software market," notes Brian Jeffery, director of research for International Technology Group, a market research firm that tracks IBM. "IBM in PC software has been a joke. The Personal Decision series, under the IBM label, wouldn't even support Topview because the Entry Systems Division forgot to provide them with the specifications.

"In early 1984, Information Programming Services was formed to spearhead IBM's movement into software," Jeffery explains. "They brought in a bunch of engineers from the host-systems area and minicomputers—and a bigger bunch of deadbeats you never did see. They don't understand a damned thing about PC software—they just rewrite old mainframe programs, like Displaywriter and their Business Management Series.

"The only time they've really gone outside the company for software is with the [Software Publishing Corp.] PFS series. And that they didn't coordinate with Information Services, so they had two competitive product lines. Their PC software just doesn't sell, like the PCjr and PC Cluster [local-network product] didn't sell." *–Jeremy L. Young*

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WATCH OUT, HACKERS, PUBLIC ENCRYPTION CHIPS ARE COMING

by Kevin Smith

LOW-COST VLSI CIRCUITS ARE FINALLY FULFILLING THE PROMISE OF SENDING SECURE MESSAGES OVER A NETWORK

London

When two electrical engineers at Stanford University came up with the idea of a public key-encryption system in the mid-1970s, the science of data encryption took a huge leap forward. But it took until now for the technology to catch up with practical very large-scale-integration implementations.

The work of Whitfield Diffie and Martin E. Hellman pointed to a data-communications future in which private messages could zip around a public data network, safe from even the most imaginative hackers. Network users would send encoded messages to each other simply by looking up the recipient's code in a directory. What's more, the system provided an unbreakable electronic signature that could be used to authenticate the identity of the sender, something that banks are now clamoring for. The setup bypassed the usual problems of cipher-key security (see "Why public key encryption?" p. 31).

Cost had limited use to defense, government, and banking sectors

Ten years later, despite intense research activity, the technology is still on the starting blocks, stalled by the high cost and slow speed of early hardware implementations. The only exceptions are in government, defense, and banking—areas where security is vital.

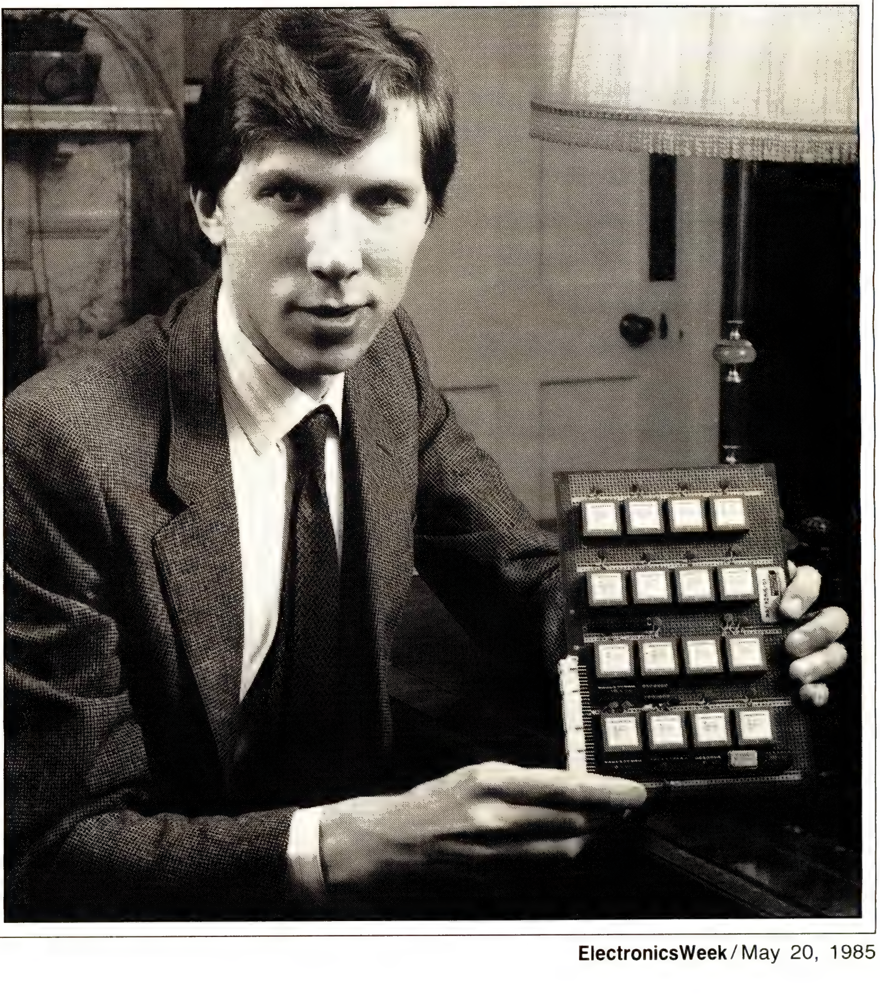
Sandia Laboratories, in Albuquerque, N.M., has long had a public key-encryption chip, but that is for internal use by the U.S. government. In Sunnyvale, Calif., Ronald L. Rivest, a founder figure in public data encryption, has been busy for some time developing a single-chip encrypter but has not yet gotten anything to market.

Now the first of a crop of smart VLSI chips looks ready to move private and public data-encryption systems out of the cloistered worlds of defense and government and into the commercial marketplace. A small British software company, Business Simulations Ltd., is ready to launch a first practical public key-encryption chip, although its lead may be short-lived—an even faster chip is reported to be in development by British Telecom Ltd.

Business Simulations is little more than a father-and-son operation, but in the esoteric world of cryptography, intellectual quality counts as much as size. Martin Kochanski, the chip's 28-year-old designer, studied mathematics and philosophy at Oxford and first took an interest in encryption for mental stimulation. He began research in 1979, and in the last two years he started designing a gate-array chip, using software he had written himself.

Sliced solution. Rather than aim for a single-chip solution—impossible in gate-array technology—Kochanski has devised a 32-bit bit-slice architecture for his fast arithmetic processor, called the

Did his exercise. Martin Kochanski treated the development of his bit-sliced encryption chip as a software exercise. It was designed entirely with IBM Macro Assembler Source Code and is now implemented by a Fujitsu C-MOS array. Each chip can handle up to 32 bits of data.



FAP4. The chip is optimized to perform those arithmetic and modulo manipulation tasks that are at the core of both number theory and cryptography.

Kochanski treated the development of his bit-sliced encryption chip as a software exercise. The chip was designed entirely using IBM Corp.'s Macro Assembler Source Code. This code was then linked with specially written interpreters to form functional and timing tests and generate the chip specifications in the form required by gate-array manufacturer Fujitsu Ltd. The approach worked well and only minor modifications were made to the design before committing it to silicon.

The chip is implemented in a Fujitsu CMOS gate array and is packaged in a 1-in.^{2} 64-lead pin grid array. This means that 16 chips will fit in 25 in.^{2} of board space. Each FAP4 chip can handle up to 32 bits of data and up to 32 identical chips can be connected in an array to handle numbers up to 1,024 bits in length. Software support in the shape of a Basic interpreter optimized for large integer calculations is also available.

The chip is also one of the fastest yet produced. When used with the widely accepted RSA (Rivest-Shamir-Adleman) scheme, FAP4 can encrypt or decrypt at more than 5 kb/s using 512-bit keys—some seven times faster than any other commercially available hardware, says Kochanski. Sixteen identical chips are used to handle 512 bits. The setup runs at 5 MHz and consumes 800 mW.

Two other British companies are in varying states of development with public key-encryption chips. British Telecom is well along with a single-chip device but has yet to decide whether to market it and is currently assessing the potential market. As a single-chip device, it should be a lot faster than the Business Simulation chip set, but British Telecom executives will not say how fast.

Meanwhile, Marconi Secure Radio Systems Ltd., part of General Electric Co. plc, Britain's largest defense contractor, is testing public key-encryption methods—including RSA—by battering them with computers. RSA, says Kochanski, has withstood such assaults for eight years, whereas others such as Knapsack and Lu-Lee have proved to be too insecure for most uses. Says Roger Castle, group manager of crypto systems at Marconi, "We certainly accept the convenience of public key-encryption [systems], but we are not yet convinced of their total strength. Also, because it involves a lot of computation, public key encryption is slow. Ideally it should be in the megabits-per-second region."

On a parallel front, chips for implementing private key-encryption systems are established in the marketplace. The two systems have complementary roles: private systems are faster, but public systems are more flexible. The best known of these private systems is the Data Encryption Standard, which has well-established silicon support. DES has been adopted by the American National Standards Institute, and will very likely become an international standard.

But there are other standards. British Telecom has developed its own encryption algorithm and has in the works a VLSI implementation called B-Crypt. This is slated for use in digital terminals for telephony and data and in office communications products. It is fast and can generate cryptographic bit streams at data rates up to 2.5 Mb/s.

'Real obstacle is to deliver encrypted key to both parties'

All of these systems use a single key for enciphering and deciphering messages. This must be conveyed to both parties before a secret channel can be established. In a large network, the problem of managing these keys is enormous. A large electronic fund-transfer network linking 100,000 terminals to about 100 banks would use 10 million individual keys, all of which would have to be changed frequently, according to British Telecom researchers.

"It is easy enough to devise an efficient encryption system to encipher data over a single link. The real obstacle to the widespread use of data encryption is to provide a cost-effective key-management system that will deliver an encrypted key securely to both parties," explains Wyn Price, a researcher at Britain's National Physical Laboratory. And it is just this role that public key encryption is being slated for.

Two British banks are already using public key encryption on their data networks. Computer data banks containing sensitive personal information may be the next to use public key encryption to control access. And longer-term public and private key encryption may be applied in videotex, teletex, local-area networks, packet data systems, and even in Telex and conventional data links. But NPL's Wyn Price cautions that it still remains to be seen if industry will take up the technology.

Absolute security will be needed in some applications. But for others, cheaper systems offering less security may be adequate. Intel's new Keprom [*ElectronicsWeek*, Feb. 18, 1985, p. 68] points up one possible trend. The only safe conclusion is that data security, in whatever form, will increasingly be needed.□

WHY PUBLIC KEY ENCRYPTION?

Unlike traditional key-encryption systems that use a single key, public key-encryption systems use two keys—one for encryption and a second for decryption. Although the single-key systems are faster, the new two-key public systems are more convenient to use—their encryption keys can be safely published in a subscriber's directory. This public directory need not be kept under tight security, and can be consulted whenever a caller needs to send a private message over a public data network.

Once a message has been encoded, neither the sender nor an eavesdropper can decipher it. Messages can only be decoded by the second key, held only by its owner. This private key can also be used to encipher an unforgeable electronic signature. A message is authenticated if the sender's encrypted signature can be unlocked by his public key and held by the recipient. Because the private and public keys form a unique combination, the author of the message must be who he says he is.

The principles of public key encryption were first worked out in 1975 by Whitfield Diffie and Martin E. Hellman, both electrical engineers at Stanford University. Their system is based on the "one-way" or "trap-door" function. As the names suggest, it is easy to put certain numbers through certain operations, but more difficult to get them back to the original state.

In their seminal work, Diffie and Hellman suggested a variety of trap-door functions, but the first practical implementation was developed in 1977 by Rondal R. Rivest, Adi Shamir, and Leonard Adleman, computer scientists at the Massachusetts Institute of Technology. Their algorithm was based on the use of certain prime numbers with apparently asymmetric complexity—making them easy to operate on, but very difficult to factor. Breaking such a code necessarily involves an enormous amount of computer time, which makes the system so secure. But by the same token, an encryption/decryption system is computation-intensive and, therefore, slower than equivalent private key-encryption systems.

–Kevin Smith

SALES TO CHINA ARE A BRIGHT SPOT FOR COMPUTER BUSINESS

by Robert Rosenberg

SMALLER U.S. FIRMS ARE LEADING THE WAY IN HACKING THROUGH BARRIERS OF LANGUAGE, LAWS, AND CUSTOMS

Washington

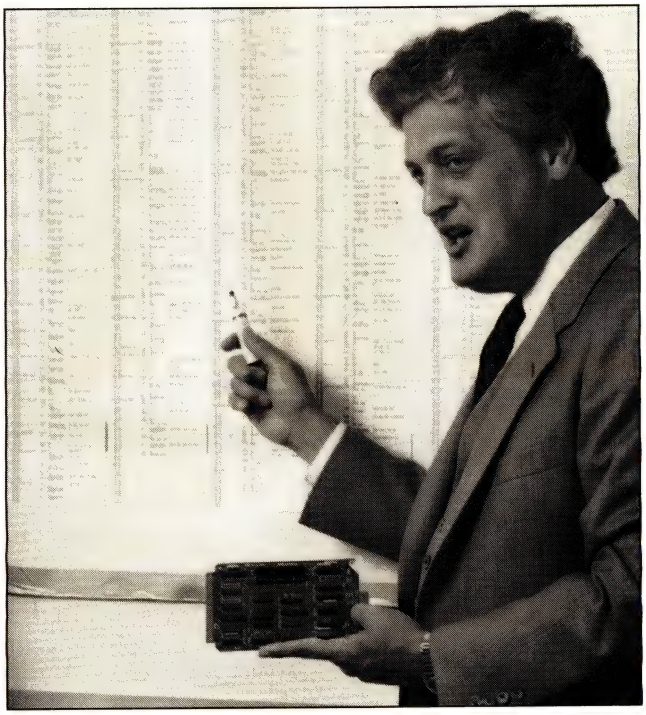
Ever since the Nixon Administration breached the Bamboo Curtain in 1972, electronics trade between China and the U.S. has been growing. This year, however, promises to be a banner year for sales to China—and for computer manufacturers, it may in fact be one of the few bright spots in an industry balance sheet bloodied by weak demand and strong foreign competition.

Some of the credit for increasing sales must go to small and resourceful U.S manufacturers. In growing numbers, they are learning to negotiate with Chinese partners across a cultural and political chasm. But to a large extent, it is the Chinese who control the size and shape of trade, and it is that fact that makes their perceptions of U.S. technology all-important.

"The man-on-the-moon paradox is our biggest cross to bear," explains Don Weadon, a specialist in technology export controls and senior partner in the Washington law firm of Weadon, Dibble, & Reahm. "The Chinese are convinced that since we put a man on the moon, we have the best technology. But they also get pretty angry when it doesn't work," Weadon says.

Statistics from the Department of Commerce on U.S. sales of all goods to the Chinese reveal some fluctuations rather than a steady rate of growth. However, the ups and downs are the result of sales of agricultural commodities; sales of manufactured items have been going up all the time, government officials say.

"Sales of equipment have shown steady growth, and electronics and telecommunications have been particularly strong," says Jeffrey L. Lee, a Commerce Department expert in Chinese trade (see chart).



China trader. Ed Lee, Pro-Log Corp.'s president, cultivated Chinese contacts for several years before taking an order. With the Chinese bureaucracy decentralizing, it is difficult to discover who's buying.

The latest jump in U.S. computer sales to China—from $211 million in 1983 to $335 million this year—is a direct consequence of Beijing's new priorities. Late last year China's highest governing body, the State Council, through its Electronic Industry Invigoration group, called for the importation and assimilation of foreign technology and products—then set aside special funds and preferential loan rates for key segments of the electronics industry.

Chinese bootstraps. The big emphasis on computers is part of China's effort to bootstrap itself to technological parity with the world's superpowers by the start of the 21st Century. To do this, the central government is pressing ahead with structural changes in Communist doctrine and government practice to accommodate Western business. New tax laws have been enacted to give overseas concerns in China the chance to work to international norms. Import duties on chips and data-processing equipment have been slashed from 25% to 6% and 9%, respectively. In April, China's first patent law went into effect, and a law protecting proprietary know-how is being drafted. But it is still too early to tell how or if these laws will be enforced.

"Only new technologies are protected and since they do not have a copyright law, we don't know if computer software is patentable," explains Eugene Theroux, a partner in the Washington office of Baker & McKenzie, a Chicago law firm.

The central government's drive to industrialize cuts two ways. At the same time that foreigners find it easier to do business, the decentralization of business decision making to local governing, production, and research and development units makes marketing trickier.

"In the past, you always knew that someone in the central government must approve a purchase. Now the central government doesn't act as a clearinghouse in all except the largest deals," says Denis Fred Simon, a professor specializing in technology transfer at the Massachusetts Institute of Technology's Sloan School of Management. "But with the greater autonomy comes the need to exercise greater care, since there are now so many administrative entities with real power you can deal with," Simon explains.

Although the government is changing certain aspects of society fast enough to suit Western business people, habits with 5,000 years of history behind them cannot be budged. A cultural bias favoring *lao pung wo,* "the old friend," translates in practice to Chinese buyers looking for long-term commitments from U.S. suppliers. With one voice, ex-

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perts on China trade policy echo the sentiments of D.C. Wigglesworth, a Foster City, Calif., technology-transfer consultant, who says, "If you are out for the fast buck, you are going to lose your shirt, but if you are in for the long term, you'll come out smelling like a rose."

Perseverance pays. Ed Lee, the president of Pro-Log Corp.—the privately held purveyor of 8-bit STD-bus technology—learned firsthand how perseverance pays off. When the Chinese discovered the STD single-board computer by accident at Wescon in 1983, they expressed little interest because they were seeking IBM Corp. Personal Computer look-alikes, Lee says. But he extended an invitation to the Chinese anyway, and in January 1984 a seminar was conducted for a visiting trade delegation at the Pro-Log plant in Sunnyvale, Calif.

Nothing happened until Lee paid a follow-up visit to China last April. "Until the April meeting, they were kind of stringing us along," says Lee. "It was only when some folks from the Ministry of Electronics saw [the computer] that we got our break. China is not monolithic; they are internally competitive and these different groups have their own priorities."

It took even longer for Aydin Computer Systems, an outfit specializing in image-processing gear, to conclude a contract. In this case, though, the Chinese went out of their way to get in touch with the Horsham, Pa., firm.

"We were contacted in 1978 about our products; in 1980 they gave us a specific problem to solve, and in 1982 we actually signed a contract," says James A. Lohr, the firm's president. "Negotiations were fairly standard. They were extremely dogmatic, yet highly skilled—not unlike negotiators here. But they had time on their side, and they used it like a lever."

For Pro-Log and Aydin, trade with China seems to be paying off. But for AVX Corp., a ceramic-capacitor manufacturer, the payback was just too far away, says Marshall D. Butler, chairman and chief executive officer of the Great Neck, N.Y., firm. After touring component-manufacturing factories in several Chinese cities, he found Chinese component technology "in the dark ages." So although AVX's multilayer-capacitor capability could have been a standout in the Chinese components industry, Butler decided "there is not much opportunity for components.

"You are looking at a two-to-three-year break-even on a capacitor factory, and you must be in it for the long term—at least five years—before seeing a profit," Butler says.

The barriers of distance and language, as well as the Chinese need to hang on to precious foreign exchange, make Butler leery of doing business in China. "I think there are great opportunities if you are selling a system and can control price and product, but as a component manufacturer, I don't feel I can control the factory—and they are looking for deals that don't require hard currency."

Licensing agreements favoring the Chinese are one way that Beijing intends to hang on to its hard currency. U.S. trade consultants warn their clients that the technology transfer to China must be carefully controlled. Otherwise, U.S. manufacturers may find that their royalty payments are simply coming out of their own pockets—from sales made by the Chinese in world markets.

"The Chinese want to compete in overseas markets to get foreign exchange to pay license fees in dollars," according to attorney Theroux. He recommends that export limits be defined as a percentage of production to prevent misunderstandings.

Joint ventures may be no picnic either, says Theroux. "I ask clients to think about setting up a California–Maryland deal, then a California–Quebec deal, finally a California–Mexico City joint venture. But China is as far out as you can go; language, culture, management—there's a lot to make it difficult."

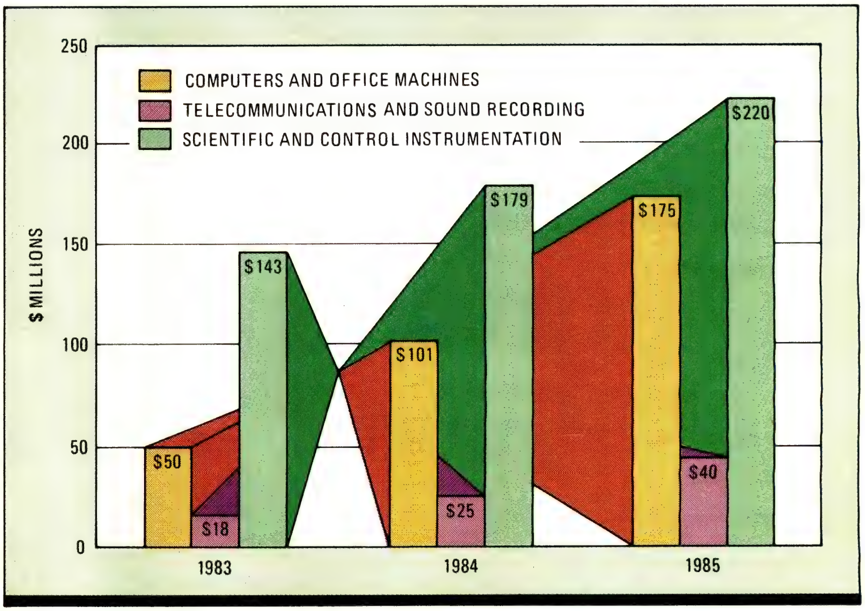
Joint ventures. Even if negotiations with the Chinese go along as smooth as silk, there is still the Washington bureaucracy to consider. Though China recently has been moved into a new trading classification that ostensibly puts it in the same class as free-world countries, export licensing remains as rigorous as for any liberal Communist country. Making the inital contacts and getting the necessary Commerce Department approval can be an "expensive and painful" process, says Lee of Pro-Log.

"We put about $250,000 into developing this maket and have only taken about $200,000 worth of orders. The initial order for $130,000 came last summer, but we only shipped this March because it took that long to get the approvals." Now that the pipeline is opened, however, Lee expects to ship on a four-week approval cycle.

Guiding Pro-Log through the Washington maze is Weadon, an attorney specializing in export-control regulations. "Small businessmen without the benefit of informed counsel think getting a license is going to be easy, but it's not so," Weadon emphasizes.

"It took us over two years from the time we had the contract till the time we had an export license," says Aydin Computer's Lohr. Even after passing the U.S. government reviews conducted by the departments of Commerce, State, Energy, and Defense, Lohr said some 250 days were needed to get past Cocom, the multinational export-control system set up by the Western alliance.

By showing plenty of patience, U.S. computer manufacturers are finally making headway; they are developing trade relationships with the Chinese and are learning the ropes to work their way through the export bureaucracy. Establishing a business relationship as an "old friend" to the Chinese takes time, and patience is needed for export licensing because, "if you forget to list anything at all, you've got to start all over again," says Lohr. ☐



Banner year. China's big electronics push (purchases from U.S. are charted), features special set-asides for computers and preferential loan rates for key areas. Emphasis on computers is part of the plan to attain technological parity with world leaders by the next century.

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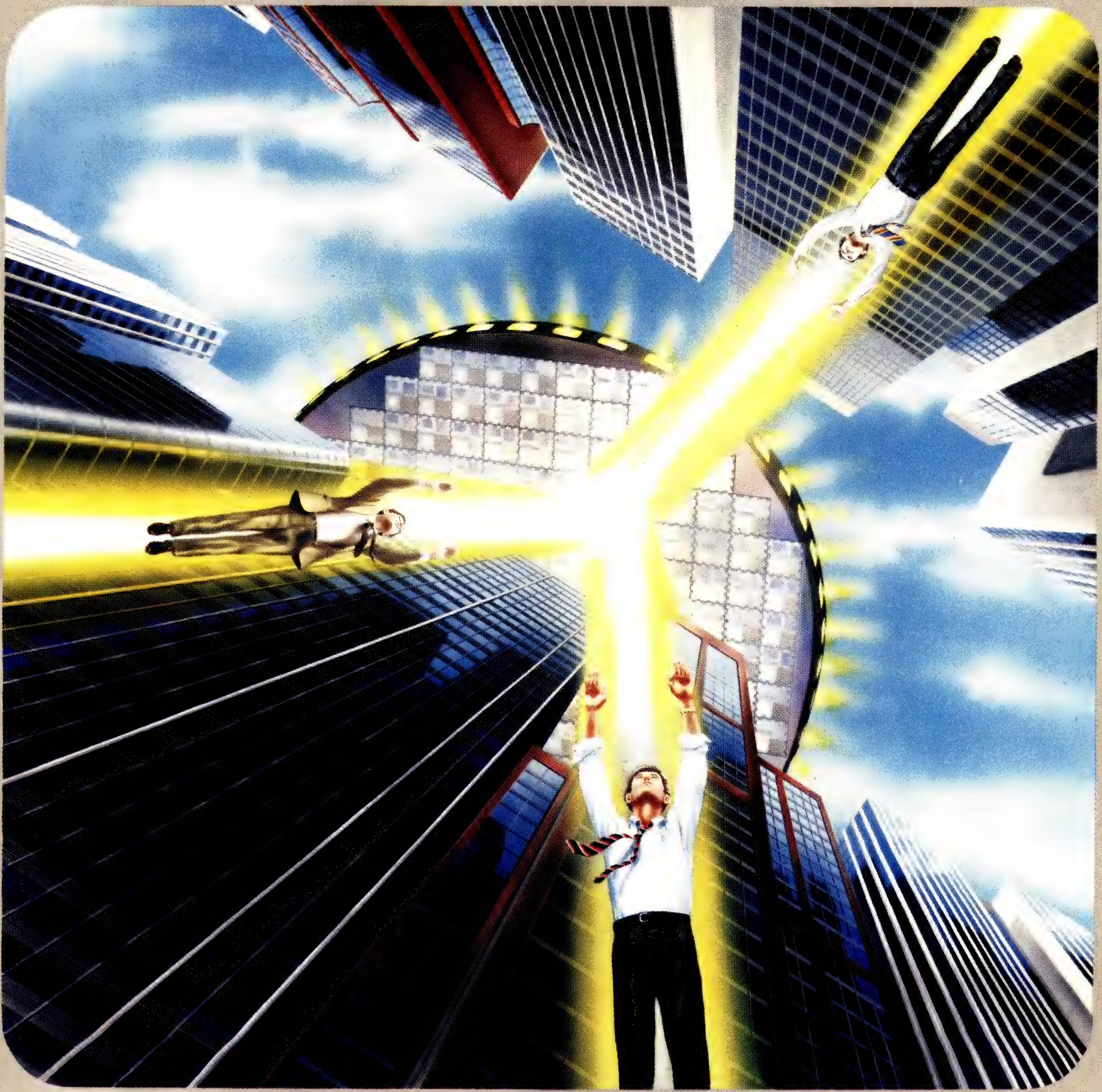

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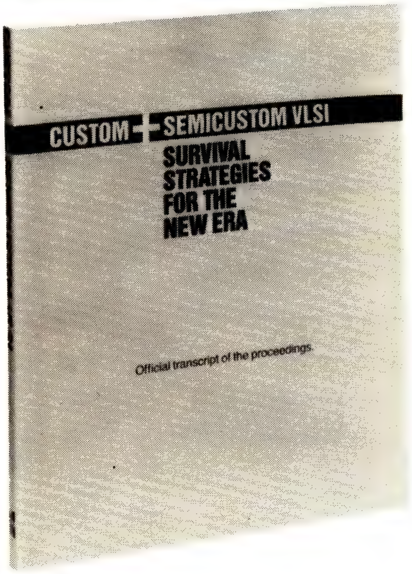
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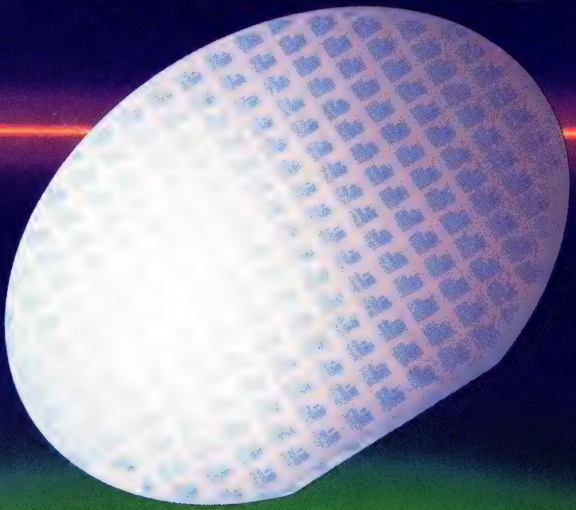

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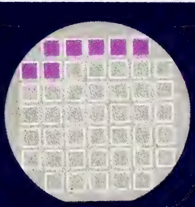

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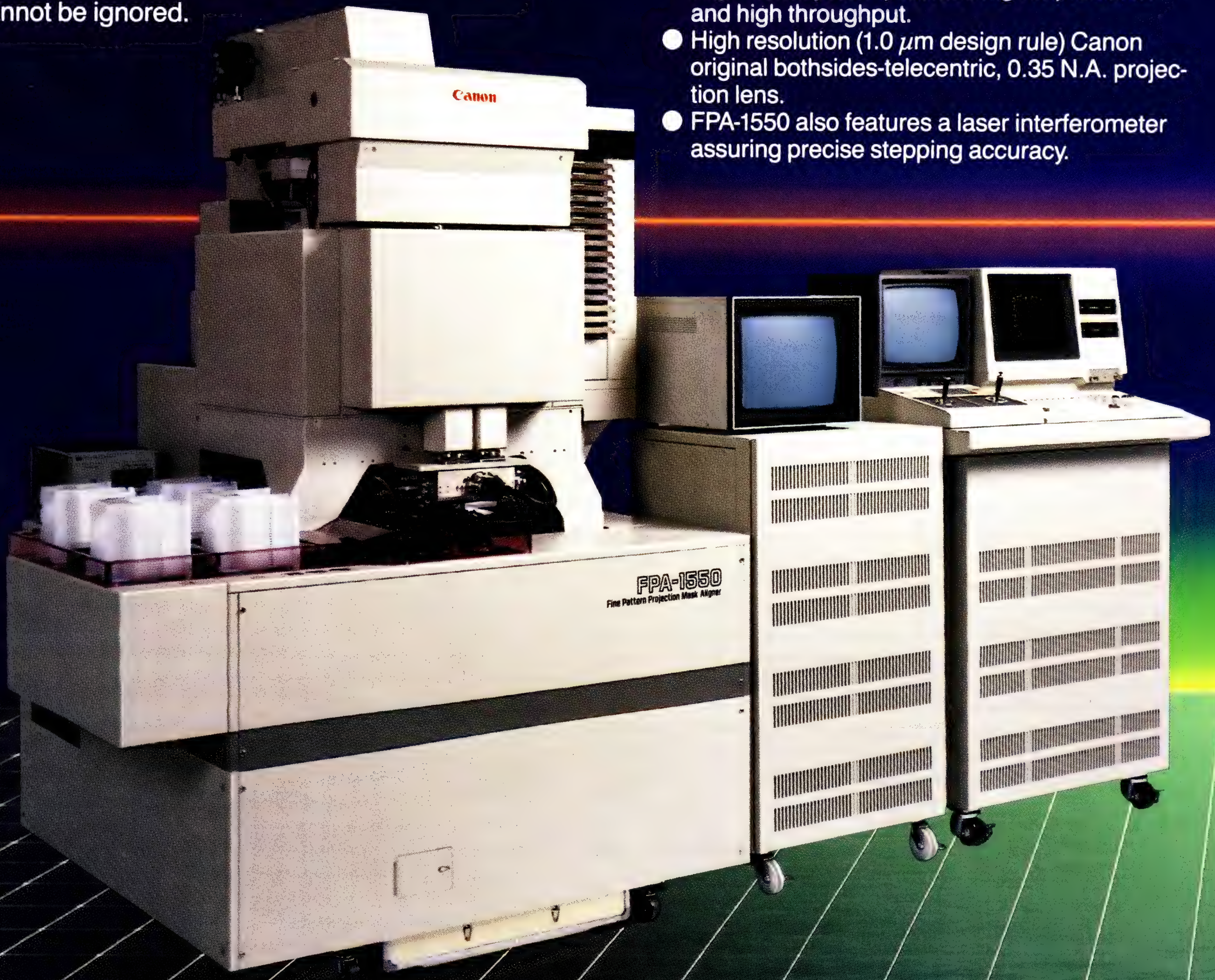

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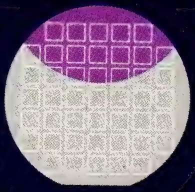

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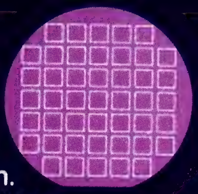

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ACQUISITIONS BOLSTER LORAL'S TECHNICAL BASE

Seven takeovers in 10 years isn't aggressive action, company says, but rather prudent business decisions to expand operations

New York

Over the last decade, Loral Corp. has spent about $300 million to acquire seven companies in the military electronics arena. Yet Loral's chief executive insists that his organization hasn't been aggressive in seeking acquisitions.

"We're just not looking to buy anybody because they're available," says Loral's upbeat chairman, Bernard L. Schwartz. Rather, Loral is interested "only if [potential acquisitions] expand or overlap to some degree the market and product position that we now have." Moreover, he contends, Loral's purchases represent the fulfillment of its strategy to expand its technology base.

Significant. The company's most recent—and perhaps most significant—acquisition was buying the Mil-Spec Computer Division of Rolm Corp. in Santa Clara, Calif. IBM Corp. had to sell the division to comply with a ruling from the Justice Department after it purchased Rolm last fall [*ElectronicsWeek*, April 15, 1985, p. 14]. Loral paid $100 million in cash for the division. Schwartz expects the government to approve the sale by the end of this month.

But even before the addition of the military computer division and another recent acquisition—Hycor Inc., a radar and military electronics maker in Woburn, Mass.—Loral was beginning to take off. In fiscal 1984, it earned $33.9 million on sales of $418.3 million. Although Loral has not yet reported the results of fiscal 1985, which ended March 31, company officials have stated they expect both sales and earnings to be up about 20%, which means sales of over $500 million and profits of about $41 million.

Last month, Loral sneaked into the vaunted Fortune 500 for the first time. It is now No. 498 on the list of U.S. industrial companies. "For a small company from the Bronx to hit the Fortune 500 is, to us, a significant milestone," says the Brooklyn-born Schwartz. "It shows that we're doing something right."

Just as surprising was Loral's ranking in a number of other Fortune 500 categories: 76th overall in net income as a percentage of sales; 196th in net income as stockholders' equity; 11th overall for average annual return to investors over the past 10 years; and 10th in earnings per share since 1974. "It even amazed us," jokes Schwartz.

Orders are impressive. "They're doing extremely well," agrees Laurence Lytton, a military electronics industry analyst with Drexel Burnham Lambert Inc. "They just made a very smart acquisition," adds Lytton, referring to the Rolm purchase. Lytton estimates Loral's annual growth rate at between 15% and 20% and says its current backlog of orders, which totaled $594 million in 1984, looks impressive.

Jon D. Gruber, a research analyst with Montgomery Securities in San Francisco, emphasizes that Loral was the only military electronics firm to reach its sales estimates last year. Moreover, Gruber points out, "They have done a good job of integrating these acquisitions."

Analysts agree that the military electronics market is very difficult to define and, hence, to quantify. According to Frost & Sullivan Inc., a market research firm in New York, total spending for electronic warfare equipment by the U.S. military will exceed $5.5 billion in the government's 1986 fiscal year after hitting a peak of $5.6 billion in fiscal 1985 (see table).

Military electronics "has been identified as being about a $12 billion to $15 billion market and it's growing at around 15% a year," Schwartz estimates. Nevertheless, "it remains a very fragmented market," explains Howard Mager, a research analyst with DLJ Securities in New York.

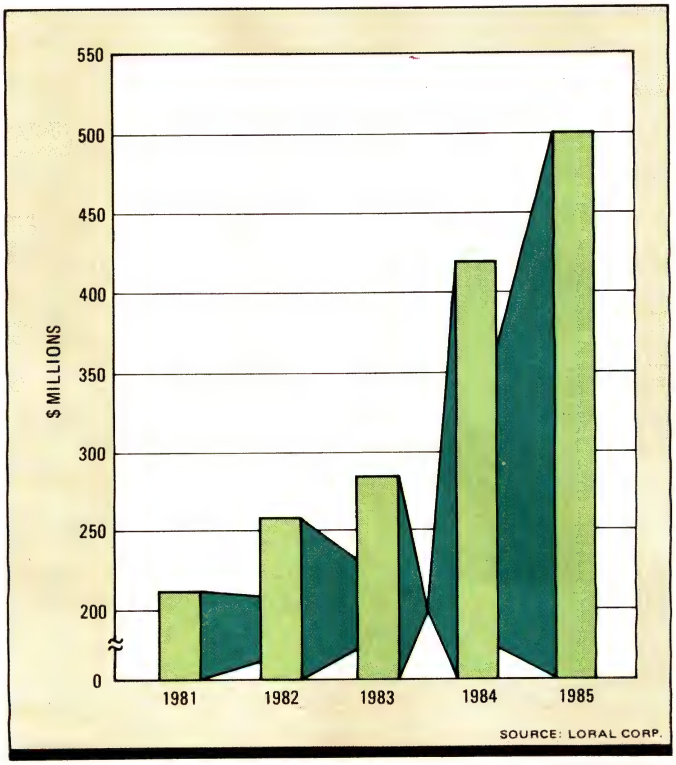
Prudent deals. Mager, who also praises Loral's acquisitions, emphasizes that the company has not overpaid for any of them and has successfully broadened its technology base. Mager calls Loral's purchase of Narda Microwave Corp. of Hauppauge, N.Y., in 1983 "a fine downward integration into components." He adds that the Hycor acquisition positions Loral well in infrared expendable-countermeasures systems and the additional exposure may help it attract more business from the Navy.

Although Mager and others downplay the significance of the firm's membership in the Fortune 500, he does think Loral's current growth has its benefits. As the company continues to grow at an estimated annual rate of 20%, Mager thinks its additional muscle will put it in a better position to compete for government contracts.

Indeed, earlier this month, Hycor received a contract worth $5.3 million to design, develop, and manufacture a threat-jammer system for the Army. It will be used for testing air-defense missiles, the division says.

According to the most recent figures compiled by Frost & Sullivan, Loral's 1983 revenue of $363 million was second among companies that operate in the military electronics field, ranking behind only E-Systems Inc. of Dallas, which finished with $500 million. "Loral's current rate, including Rolm, is about $700 million in annual sales," says Schwartz. Nevertheless, he adds, "we still represent only 4% of the market."

Founded in 1948 by William Lorenz and Leon Alpert (who joined the first letters of their last names to form the company's name), Loral's first move into military electronics was to provide the



SOURCE: LORAL CORP.

Strong performer. Loral's sales skyrocketed 48% in fiscal 1984, following a 10% gain in fiscal 1983. Loral predicts another 20% gain in fiscal 1985.

U.S. ELECTRONIC WARFARE FUNDING ($ millions per fiscal year)

	1983	1984	1985	1986	1987	1988
Army						
Research, development, test, and evaluation	332.9	373.1	397.0	373.6	378.2	379.2
Procurement	160.0	375.7	461.4	430.0	428.0	437.0
Total Army	**492.9**	**748.8**	**858.4**	**803.6**	**806.2**	**816.2**
Navy						
RDT&E	466.1	555.9	627.9	685.2	699.1	708.1
Procurement	771.9	956.1	1,307.2	1,159.5	1,067.5	1,074.9
Total Navy	**1,238.0**	**1,512.0**	**1,935.1**	**1,844.7**	**1,766.6**	**1,783.0**
Air Force						
RDT&E	726.5	866.4	885.0	886.4	869.5	873.2
Procurement	608.8	912.6	1,899.0	2,002.0	2,057.4	1,935.6
Total Air Force	**1,335.3**	**1,779.0**	**2,784.0**	**2,888.4**	**2,926.9**	**2,808.8**
All services						
RDT&E	1,525.5	1,795.4	1,909.9	1,945.2	1,946.8	1,960.5
Procurement	1,540.7	2,244.4	3,667.6	3,591.5	3,552.9	3,447.5
Total spending	**3,066.2**	**4,039.8**	**5,577.5**	**5,536.7**	**5,499.7**	**5,408.0**

SOURCE: FROST & SULLIVAN INC.

Navy with radio equipment. Since going public in 1959, it has held contracts with each of the four services.

Two years after Schwartz assumed the helm in 1972, Loral's period of corporate expansion began with the purchase of the Conic Corp., a San Diego manufacturer of telemetry and instrumentation equipment. "I think we have a style of management in this company that allows for modular additions," explains Schwartz, 59.

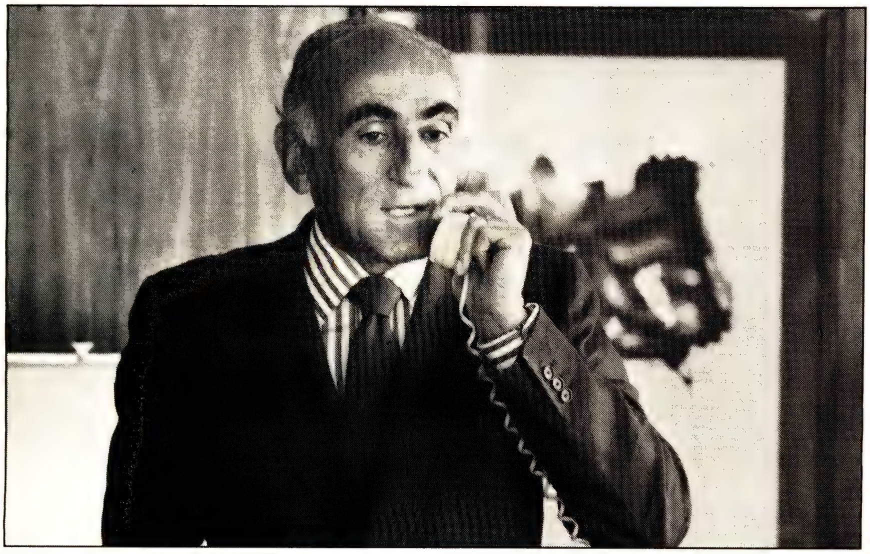
Strictly military. The key to the company's acquisition policy is to remain strictly within defense electronics. Rolm's Mil-Spec Computer Division, which will become Loral's 17th division, "is directly within the main thrust of Loral's forward planning: defense [and] high-tech electronics systems," he notes.

Schwartz, who recently received the *Wall Street Transcript's* gold award as the top executive in the aerospace/electronic warfare industry in 1984, bristles at suggestions by critics of the defense industry that modern weapons systems are too complex and costly. Nevertheless, he acknowledges that "we need to do more as an industry to train our personnel . . . but I do not believe that the science of war is going to wait for those developments."

As the number of divisions grows, Schwartz says Loral has been able to retain its strong sense of community. His favorite example is the company's plant in the Bronx—among the firm's oldest. Loral's most sophisticated electronics warfare systems are manufactured there, says Schwartz, but the plant's productivity and stability more than compensate for the area's relatively high labor and transportation costs.

"That community flavor is not only a question of moral responsibility by corporate managers," the chief executive points out. "It also makes good business sense." *–George Leopold*

Selective. Loral's acquisitions over the past decade have been carefully designed to strengthen the company's position in military electronics, says chairman Bernard L. Schwartz.



BOTTOM LINES

Defense production growth slips

If the Reagan Administration's current plans for defense spending are implemented, the projected average annual real growth rate in U.S. industrial production for defense will hit 8.1% between 1985 and 1990, according to a new study by Data Resources Inc., a unit of the McGraw-Hill Financial & Economic Information Co. This will almost equal the 8.8% rate in production recorded over the 1981 to 1984 period, DRI says. The study further estimates that within the durables manufacturing segment of the U.S. economy, the defense share of production has risen from 8.4% in 1980 to 10.9% today, with a further increase to 13.1% projected by 1990.

California leads all other states in the amount of industrial production for defense with $63.1 billion in 1985, well above Texas's second-place $24.6 billion figure. Rounding out the top five are New York (with $21.7 billion in defense production), Virginia ($16.5 billion), and Florida ($13.8 billion).

Wyle Labs completes acquisition

Wyle Laboratories, a diversified electronics company in El Segundo, Calif., has completed its acquisition of Applied Research Inc. of Los Angeles for an undisclosed number of shares of Wyle common stock. Wyle officials said the acquisition of ARI, which will become part of Wyle's Scientific Services and Systems Group, will have "an immediate beneficial impact" on Wyle's work in the commercialization of space and the development of a permanent space station by the National Aeronautics and Space Administration. ARI provides management and technical consulting services to the Defense Department, the Department of Energy, and industrial, aerospace, and defense contractors.

Convex ships first unit, raises funds

Convex Computer Corp. has shipped the first production unit of its C-1 supercomputer, a 64-bit scalar and vector processor, to Technology Development of California. According to Convex, the C-1's architecture is similar to that of supercomputers made by Cray Research Inc. Convex also disclosed that it has raised $10.8 million in a third round of venture financing and that it has secured a $24 million line of credit.

Computer firm completes financing

Silicon Solutions Corp., a manufacturer of special-purpose computers, has completed a second round of venture capital financing totaling $3.35 million. The two-year-old Menlo Park, Calif., company said the funds will be used to finance its product development.

HAMILTON APPLIES AXIOMS TO SOFTWARE STUDY

Cambridge, Mass.

For Margaret Hamilton, who worked for a decade on the Apollo space project, the mission ended as much with a letdown as it did with the splashdowns. After being involved in a giant leap for mankind, Hamilton, who was the director of software efforts for both the command and lunar modules, faced the question of what to do for an encore.

So Hamilton, who is 48, decided to take a hard look at the work she had done for the Apollo program. She says, "So much had gone on and we didn't want to lose it. We wanted to summarize it for ourselves." Hamilton and her group embarked on a detailed analysis of the way software had been developed for Apollo.

That $250 million effort had provided engineers with an "opportunity to do nearly everything wrong," she says. Yet the analysis revealed that 73% of the errors were interface errors or errors of ambiguity or inconsistency. And although the most sophisticated automated error-checking techniques were employed, 44% still had to be found manually. What's more, more than 60% were found in work believed to be flight ready.

The results led Hamilton and coworker Saydean Zeldin to develop a set of rules to eliminate interface errors in the design phase, believing this could save vast amounts of time. Later, she saw that the rules could be formalized, form the basis for a theory, and be expressed in mathematical form as axioms.

It's axiomatic. The idea of providing interface integrity at the front end is not new to other kinds of engineering, but is to software engineering, Hamilton says. "If you're building a building, you don't just build and then say, 'What did I do wrong?' No one had brought software analysis to the level of axioms. It was something that in hindsight we should have done first."

With this approach, a formal axiomatic system definition and development methodology emerged. By 1976, the methodology was named Higher Order Software and Hamilton was ready for her encore: she and Zeldin cofounded Higher Order Software Inc. She is now its president and chief executive officer; Zeldin serves as chief financial officer.

Work on government projects proved the methodology's feasibility. In 1982, the firm introduced a computer-aided software tool called Use It, which helps programmers create consistent specifications. The software was made available first for Digital Equipment Corp. machines, and Hamilton's company recently announced that it is available for IBM Corp. mainframes. *–Craig D. Rose*

Methodical. Margaret Hamilton used Apollo lessons to form Higher Order Software Inc.

RITCHIE HEADS RESTART EFFORT AT CALIFORNIA DEVICES

San Jose, Calif.

Douglas Ritchie is quite certain about his work. "I was born to be in a semiconductor company," he says. Now, after "15 years at hard labor" in semiconductor processing, he thinks he has finally found his niche. In April, he was named president and chief executive officer of California Devices Inc.

Though the firm has been making semicustom integrated circuits since 1978, Ritchie says it has been virtually restarted in the past few months with new management and a request for investors to provide more capital and wait longer for returns. It is also arranging a deal to marry its innovativeness to a major chip maker's manufacturing skill.

Ritchie started his career with Tektronix Inc. in 1969, rising to process technology manager of its in-house IC operation within months. After realizing its oscilloscope market share had eroded from 90% to about 70%, the company saw it needed a superior product line and decided the only way to do that was to develop a new IC process technology, he says. The product line was successful and the experience made the importance of semiconductor processing clear to Ritchie.

By 1975, he headed the solid-state research division for Tektronix, but felt frustrated in 1980 and 1981 when he saw that many good business ideas were being developed outside his company by startups such as Mentor Graphics, Daisy, and Valid Logic. Also, it seemed to him that his commitment to semiconductor technology ran against the current in a company where chips are not the end product.

No higher. After nine years at Tektronix, Ritchie spent six years at Burroughs Corp. in San Diego, becoming program general manager of its silicon operations. He left when it became clear he could go no higher in the firm and still work with semiconductors.

He went to National Semiconductor Corp. in 1983 as vice president of the custom products group, hoping he had finally found his proper place in the industry. Yet Ritchie's experience in developing application-specific ICs left him longing to be in a more focused firm.

While at National, he concluded that there were two types of competitors in the application-specific IC market. The first type, of which California Devices is a member, Ritchie sees as tightly focused, synergistic, and service-oriented. National fits the other type, which has lots of resources and can afford to routinely develop new technologies.

Ritchie says he left National because "it is more personally satisfying to be in a highly focused organization." He also believed it was time to make the move so he could play a role in the application-specific IC market at its most exciting time—he expects it to peak in the late 1980s or early 1990s. *–Eve Bennett*

Determined. Douglas Ritchie of California Devices is committed to semiconductors.

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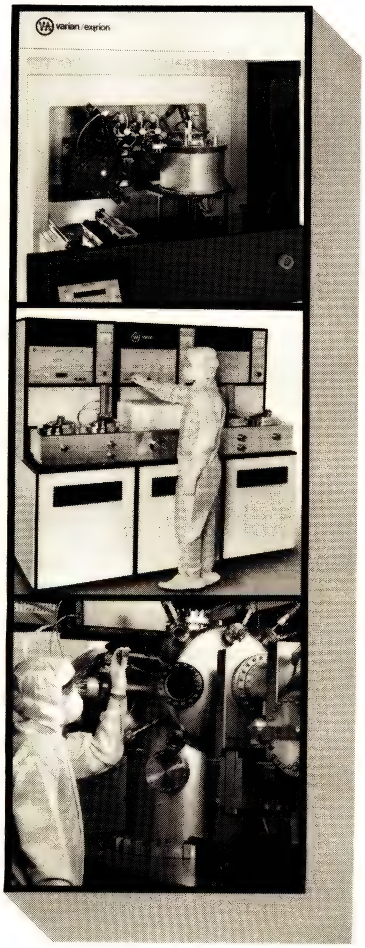

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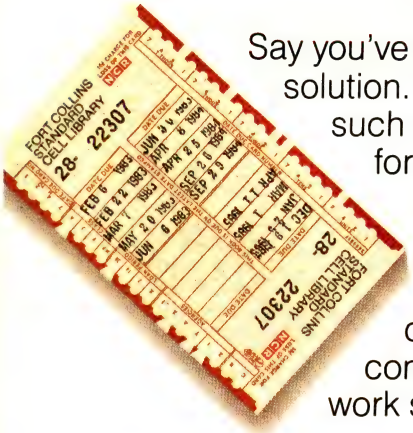

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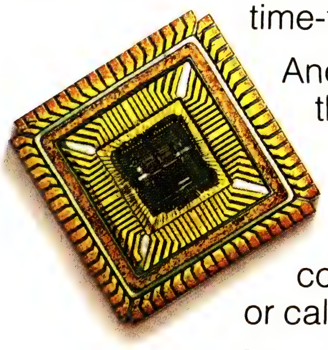

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MMICs SAVE SPACE, INCREASE RELIABILITY, AND IMPROVE PERFORMANCE

by Jerry Lyman

GALLIUM ARSENIDE ANALOG CHIPS WITH SUBMICRON FET GATE LENGTHS WILL SHRINK RADAR, ECM, AND SATCOM CIRCUITRY

While most attention has been focused on hybrid and integrated circuitry at relatively low frequencies, microelectronics has found its way into the world of microwave analog circuitry, which reaches from about 100 MHz to 20 GHz. For some time now, microwave manufacturers have been fabricating microwave ICs (MICs) for radar and electronic countermeasures (ECM) applications. Within the last two to three years, an analog monolithic-microwave-IC (MMIC) technology has emerged, based mainly on gallium arsenide.

MICs are miniaturized assemblies based on thick- and thin-film hybrids, which radically compressed the packaging volume of the previous modular approach (Fig. 1). MMICs, on the other hand, are lighter, smaller, and more reliable than their MIC counterparts because all necessary components are integrated on the same substrate, decreasing component count and eliminating failure-prone operations such as wire- and die bonding required in hybrid fabrication.

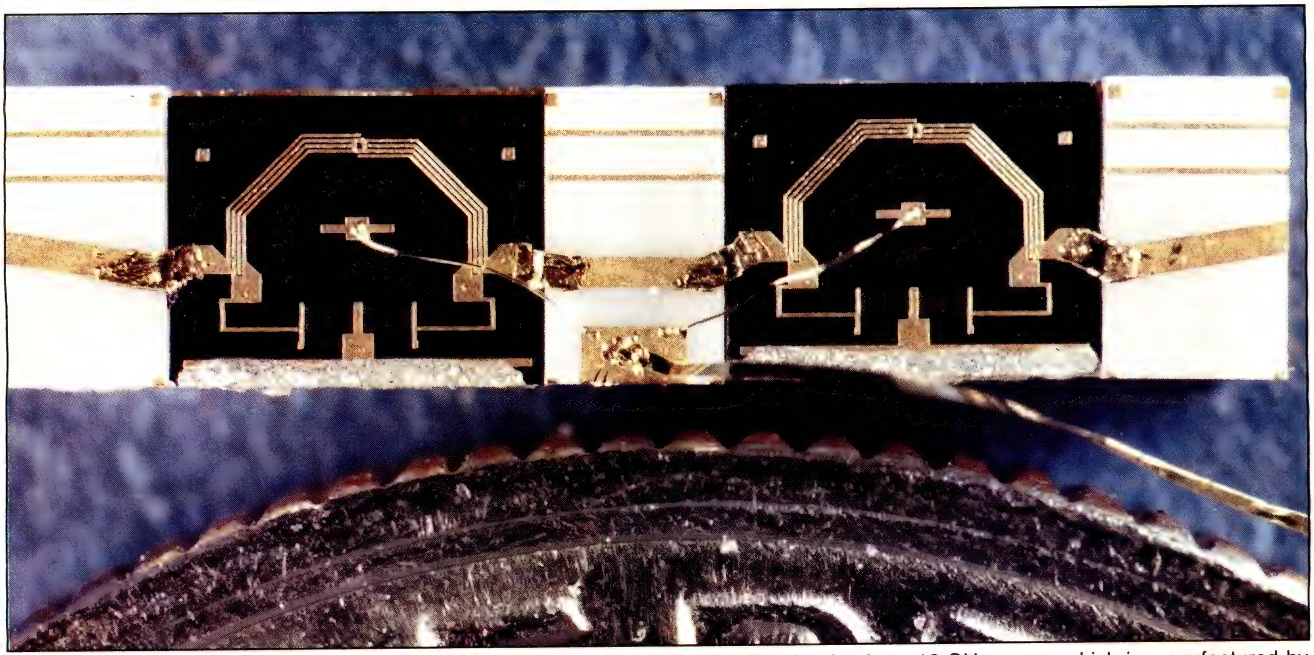
Currently, MICs dominate the microwave world; most MMICs are still in prototype or pilot production. Actually, when the MMICs do arrive in full force, they will be integrated into even more complex MICs, because MMICs require the short line widths and microstrip interconnections of the MICs to operate at their full capabilities.

An MIC is actually an assembly consisting of a number of small substrates with die- and wire-bonded leadless passive and active components housed in cavities on a larger metal plate, linked together with extremely short copper ribbon leads. The substrates, which are usually quite small, can be thick- or thin-film hybrids, subtractively etched high-frequency "soft substrates," or a combination of these types. A typical MIC, an Avantek mixer-preamplifier assembly, uses a microwave mixer on a soft substrate and two thin-film amplifier stages on ceramic substrates, all mounted in a cavity hollowed out of a metal block (Fig. 2).

Thick-film MICs on alumina substrates are currently being used for up to 4 GHz. For example, RCA Corp.'s Government Systems Division, Moorestown, N.J., is making copper thick-film analog radar circuits that operate at 2 GHz. Thin-film MICs, with their finer lines, can operate above 20 GHz.

For higher-power applications, beryllia, with a higher thermal conductivity than alumina, can be used as a thin-film microwave substrate. A recent paper at Electro/85 in New York by Franco N. Sechi of RCA Laboratories, Princeton, N.J., described some new miniature beryllia circuits based on a new type of processing. These circuits are small and light and can be batch fabricated.

Fabrication starts with the preparation of a special ceramic substrate that includes a copper septum for a low-inductance ground return. Alumina or beryllium oxide plates—two for a single septum structure—are copper metallized on one side, pressed in a fixture, and placed in a high-temperature fur-



Microwave phase shifter. The gallium arsenide monolithic analog phase shifter for the 8- to 12-GHz range, which is manufactured by Westinghouse, is composed of a Lange coupler and back-to-back varactor pairs. The device's phase shift is continuously variable.

nace. The solid diffusion between the copper layers results in a very strong thermocompression bond. The sandwich (Fig. 3a) is then sliced into thicknesses of 10 to 15 mils. The resulting substrates are then polished on both faces.

In the next series of process steps (Fig. 3b), the substrate strip's top surface is covered with a glaze to make the surface suitable for thin-film-capacitor fabrication. Selective glazing leaves the metal septum and pads for a FET uncovered. Tuning circuits are then batch-fabricated on the glazed surface. The circuits include high-Q inductors, capacitors, and bridges for interconnections. After testing, the strips are diced into separate circuits and flip-chip FETs are bonded to the circuit.

In the miniature ceramic circuits, the thin-film base conductor forms the ground contacts, the bottom electrodes of the capacitors, inductive lines, and the first level of interconnection (Fig. 3c). A thin film of silicon nitride is the capacitor dielectric. Another metal layer forms the second layer of interconnection, the top electrodes of the capacitors and bridges supported by polyimide. This structure has many features of the MMIC, as will be seen later.

The MCC structure allows the fabrication of high-Q inductors, which are particularly important for high-performance circuits where low losses are mandatory. The high Q of the thin-film inductors derives from the relatively thick substrate used in the MCC structure. In monolithic power circuits, substrates are only 1 to 4 mils thick, resulting in inductive lines that are very narrow and therefore tend to be lossy—that is, to lose electrical energy.

Using the MCC technology, a 7-by-9-by-1.6-cm transmit/receive module was constructed for operation at 16 to 16.5 GHz with an average power of 4.15 W. The same techniques allowed construction of a 4-GHz low-noise amplifier and an active antenna subarray.

In general, most thin-film MICs are made with a more straightforward process resulting in alumina substrates with gold conductor patterns having anywhere from 1- to 3-mil widths. Normally, the back side of the substrate has a gold groundplane to allow for microstrip transmission lines. Passive components can be chip resistors and capacitors and thin-film spiral inductors. Active components used are GaAs signal and power FETs, bipolar transistors, and p-i-n and varactor diodes in chip form.

Soft substrate

As has been noted, not all MIC substrates are alumina-based. The so-called soft substrates are based on printed-circuit processing and specialized pc-board laminates available from Rogers, Keene Laminates, and 3M. There are really two classes of soft substrates: PTFE (polytetrafluoroethylene) with glass and PTFE with a ceramic binder. Both types have copper laminated to both sides. Subtractive etching is used to form circuit patterns on the top of the board; the bottom copper is used as a groundplane for microstrip. The glass-reinforced boards can either have a glass weave or dispersed glass particles in the PTFE resin. The dielectric constant of this type of board ranges from about 2.2 to 2.5.

The PTFE-ceramic laminate, which costs about six times the price of the PTFE-glass material, has a dielectric constant of about 10, which is close to that of alumina. This high dielectric constant allows the width of 50-Ω lines to be reduced just as it is on alumina substrates because the width of a microstrip line is inversely proportional to the square root of the effective dielectric constant of the stripline medium. In addition, the PTFE-ceramic material can withstand a higher temperature than the PTFE-glass and has better dimensional stability (an important factor in holding a microstrip line's characteristic impedance within tolerance).

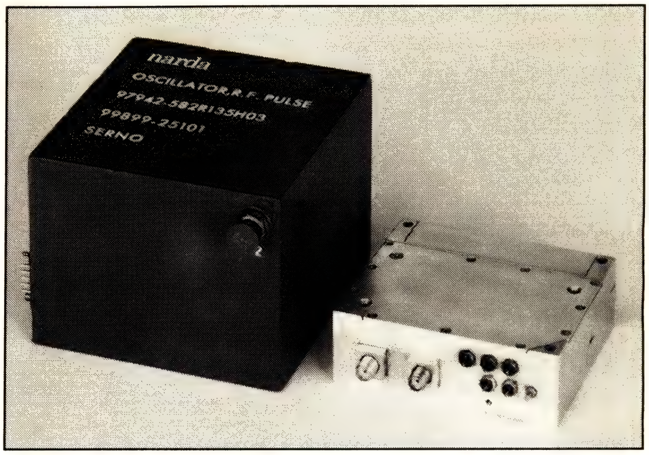
Westinghouse Defense Electronics Center, Baltimore, recently had nearly a 50% reject rate and a long, costly assembly in military radar amplifiers. The cause was the cracking of alumina circuit-board substrates during assembly. At Westinghouse, the production engineers' solution was to switch to a Keene Laminates PTFE-ceramic material. This material, which can be drilled, punched, and machined easily, unlike the brittle alumina, eliminated the cracking, reduced the cost of the material fivefold, and radically lowered the reject rate.

Besides military applications, the soft substrates are finding markets in community-access television, satellite communications, and digital radio.

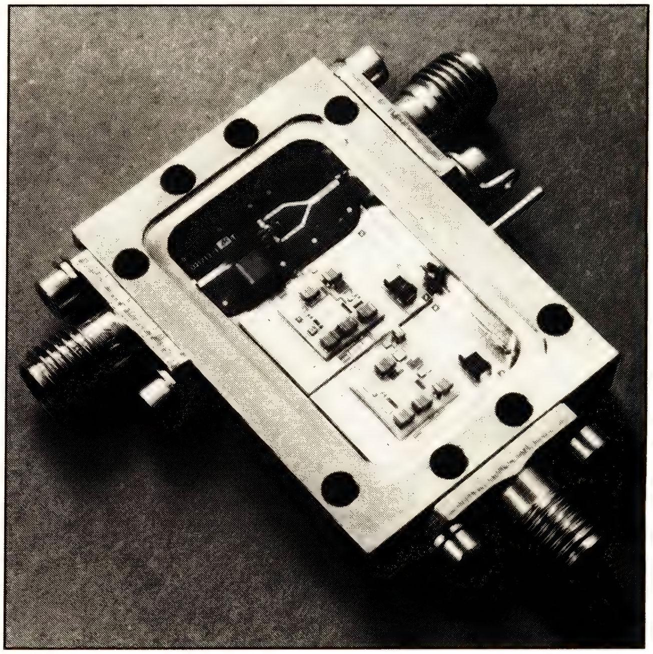
A GaAs explosion

The microwave industry is currently in the middle of a transition from MICs to MMICs. And it appears that the fabrication of MMICs will be based mostly on semi-insulating gallium arsenide wafers.

The GaAs MMICs will be more reliable, lower in cost in large quantities, have excellent amplitude and phase matching from chip to chip, have good radiation hardness, and will cut packaging space requirements from 7 to 10 times when com-



1. Microwave compression. Microwave integrated circuits allow the Narda rf-pulse generator (shown right) to be radically reduced in volume over a version based on the use of modular components. MICs are mainly used in military applications such as radar and ECM.



2. Microwave integrated circuits. The Avantek integrated mixer-preamplifier uses thin-film MIC construction throughout. It incorporates a double-balanced mixer made on a PTFE-glass substrate and several amplifier stages fabricated on ceramic substrates.

pared to MICs. The new analog MMICs are expected to result in a variety of systems applications such as active-element phased-array radars, jammers for ECM, and receivers for direct-satellite television broadcasting.

Gallium arsenide is an ideal semiconductor for MMICs because of its high electron mobility and its insulating properties. The high electron mobility permits the fabrication of high-speed devices, and the semi-insulating properties permit the substrate to act as the dielectric medium onto which passive matching circuitry is fabricated.

The key element in a GaAs MMIC is the metal semiconductor (Fig. 4). The structure is formed on a semi-insulating GaAs substrate. The conducting layer is formed by epitaxial growth or by direct ion implantation. Doping of the conducting layer is n-type. Current flow between the ohmic source and drain contacts is modulated by changing the voltage on the Schottky-barrier gate. The current-handling capacity of the FET is determined by the gate width.

In low-noise amplifiers, the FET is designed to minimize device noise and maximize gain. Low-noise amp FETs require low gate capacitances and low source resistance. This can be done by reducing the gate length to 0.5 μm or less. This submicron dimension can be achieved by deep ultraviolet lithography or by direct writing with an electron-beam lithography system. Power FETs, on the other hand, require gate lengths from 1 to 10 mm.

Processing of a GaAs MMIC is quite different from that of a silicon type. The analog MMICs have unique features such as spiral inductors, monolithic capacitors, and air bridges, and are much less dense than silicon digital ICs. A flow diagram for processing GaAs wafers that is being used at Texas Instruments Inc. is shown in Fig. 5.

To start the process, a continuous n-layer is formed over the entire wafer surface using either ion implantation or epitaxial deposition. To provide isolation, the n-type active layer is mesa-etched to remove it from all areas of the wafer except where the active FETs or diodes will be formed. Other approaches for this process step include selective ion implantation of the active area using a photoresist mask or ion bombardment of the area surrounding the active region to destroy the conductivity.

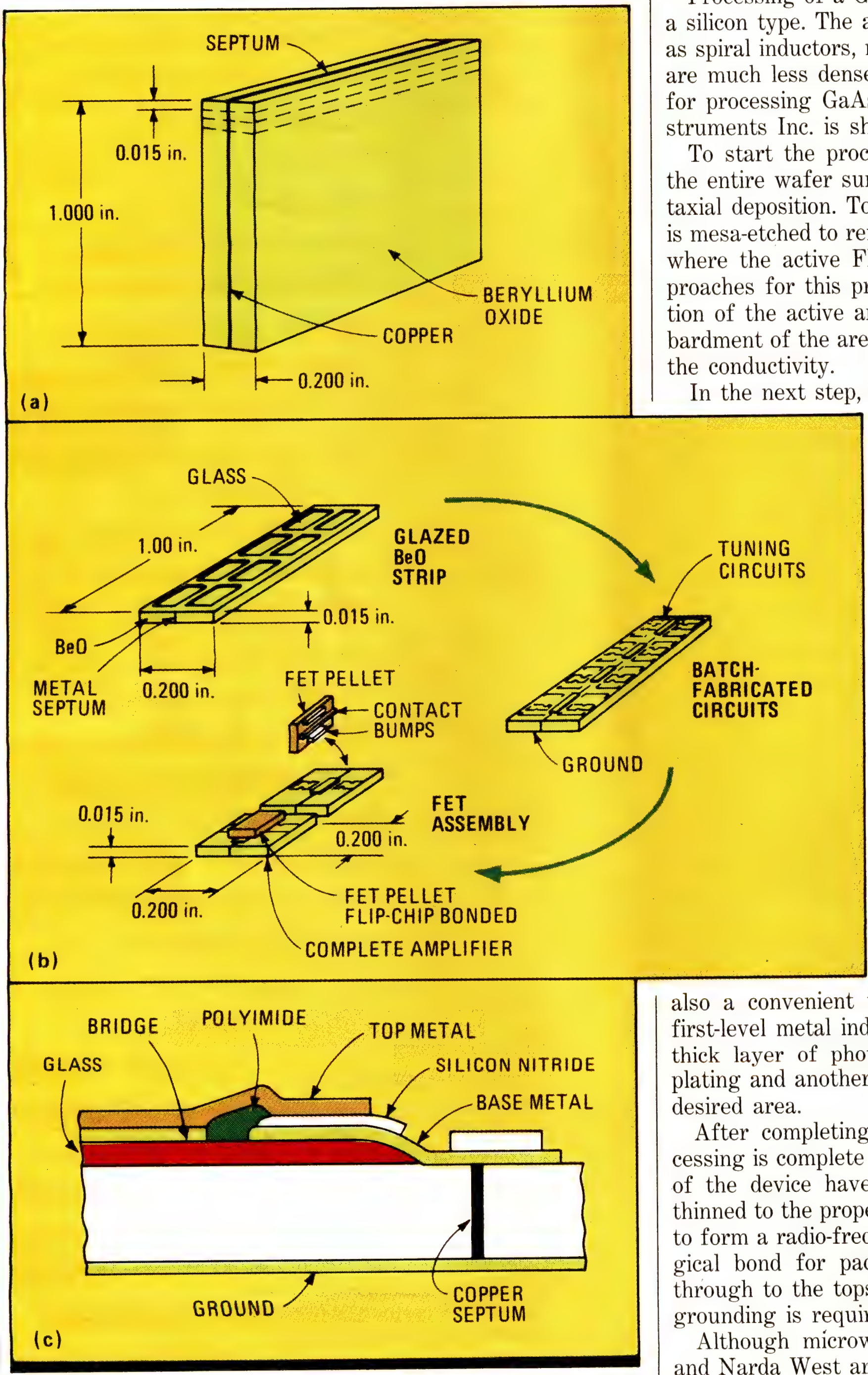
In the next step, source/drain ohmic contact metallizations are formed by using photoresist lift-off on a gold germanium nitride layer. Following this comes the critical step of Schottky-gate metallization. Here, electron-beam lithography is used for the submicron gates (currently between 0.5 and 1 μm). This allows high uniformity of submicron lines on large wafers.

After this, the first level of metal is deposited and patterned by lift-off to simultaneously form the inductors and the bottom plates of the capacitors, and also to overlay the source and drain regions to reduce spreading resistance. Next, silicon nitride is plasma deposited as the capacitor dielectric followed by deposition of a metal layer to form the capacitor top plates.

Gold-plated air bridges are used to form low-conductor-loss, low-parasitic-capacitance connections between source regions of multiple-gate FETs. This is also a convenient way to connect capacitor top plates and first-level metal inductors without step-coverage problems. A thick layer of photoresist supports the gold bridge during plating and another layer of resist confines the plating to the desired area.

After completing the preceding steps, topside wafer processing is complete and all the micron and submicron features of the device have been formed. The wafer must then be thinned to the proper thickness and metallized on the backside to form a radio-frequency groundplane and a strong metallurgical bond for packaging. In some cases, vias are etched through to the topside and backfilled with plated gold where grounding is required in the interior of the circuit.

Although microwave companies such as Avantek, Gould, and Narda West are producing commercially available analog MMICs (mainly amplifiers), most advanced MMIC design is going on in completely captive facilities at companies deeply involved with military radars such as TI, Raytheon, Westinghouse, and many other major defense contractors.



3. Miniature ceramic circuits. Fabrication of an MIC starts with a special ceramic-copper-ceramic structure (a) which is sliced into 10 to 15 mils substrates. These in turn are batch processed (b) into multiple circuits. The cross section (c) shows various interconnection layers.

Raytheon Corp. has been working on analog MMICs for about six years and has made MMIC designs for power amplifiers (1-W range), low-noise amplifiers, and switches and phase shifters for phased arrays. At low microwave frequencies, Raytheon uses a process to produce discrete passive components. For higher-frequency applications, it designs its circuits with distributed elements.

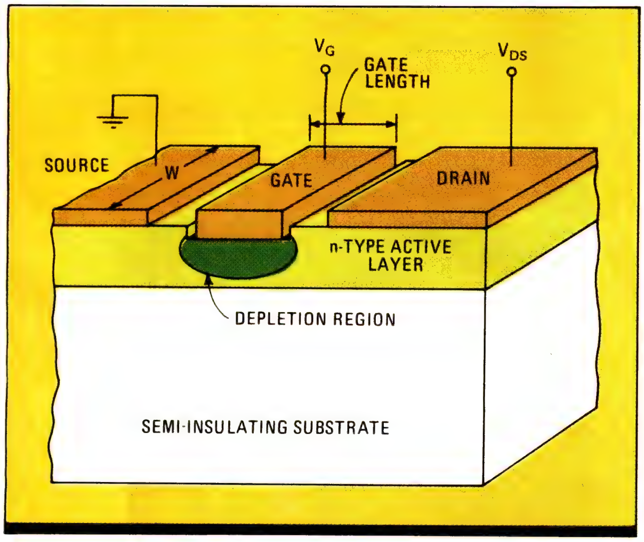
Raytheon's engineers currently use optical lithography to form most MMIC features but go to direct-writing electron-beam lithography to expose the critical 0.5-to-1-μm gate lengths of GaAs FETs. Three-inch GaAs wafers are processed on a modern cassette-to-cassete fabrication line. Typical chip sizes range from 2 by 3 mm to as big as 0.3 in. on a side. Raytheon's goal is to reduce chip sizes to 1 by 1 mm.

Westinghouse's Defense and Electronics Center is mounting a major effort in analog GaAs MMIC technology mainly in the area of airborne radar applications. As a major radar contractor, it has set up a pilot line for MMICs with full optical lithography, processing, and test facilities.

Rather than use vapor-phase epitaxy to grow the active layer over the entire wafer, followed by mesa etching to define the active FET region, direct selective ion implantation is used. In this process, impurity ions are accelerated by a high potential and bombard the wafer surface, literally embedding or implanting impurities in the surface.

By implanting through a mask into high-purity, high-resistivity substrates, the active regions can be formed only where desired, leaving the remainder of the substrate available for low-loss microwave matching circuitry. This technique is totally planar and produces a uniform active region. The two-stage amplifier (Fig. 6) is based on this type of ion implantation. Chip size for this device is 2 by 5.2 by 0.1 mm; power is greater than 1 W with 9-dB gain across the 8- to 12-GHz band.

Microwave FETs, in addition to their amplifying mode of operation, can also be used in a switching mode to provide control functions such as phase shifting and rf switching. An example is the two-section analog phase shifter (see p. 52) developed by Westinghouse for an 8- to 12-GHz transmit/receive module. Each 180° phase section occupies a GaAs chip with dimensions of 2 by 2.5 by 0.25 mm. Monolithic surface-oriented Schottky-barrier varactor diodes are situated at the ends of the Lange coupler to provide continuously variable phase shift with an analog control voltage. Phase-shift variation with power level is reduced by using back-to-back varactor diodes.

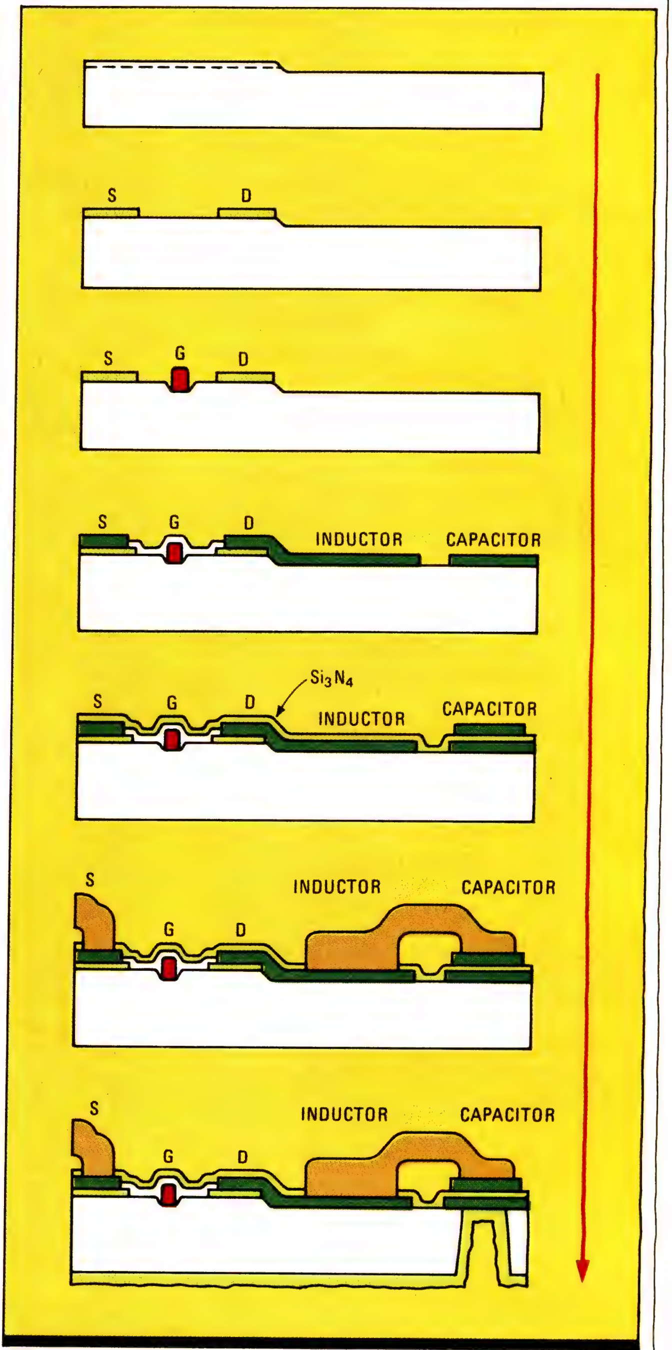


4. The GaAs MES FET. The basic building block of both MICs and MMICs is the gallium arsenide metal semiconductor FET. One of its most critical parameters is gate length, which has an effect on both high-frequency operation and the noise figure.

This phase shifter is one fifth the size of an earlier digital design and has significantly reduced circuit complexity because each individual chip contains only four air bridges, four diodes, no overlay capacitors, and no vias.

MMICs have been developed at TI for a variety of purposes. These circuits are generally designed using well-characterized submicron-gate GaAs FET types in a chip layout that makes use of metal-insulator-metal capacitors and high-impedance microstrip lines as inductive elements. This semi-lumped element approach minimizes the amount of chip area consumed by passive circuit elements. These element values are optimized using computer-aided design. On some circuits, plated vias are used to ground the points within a circuit.

A four stage X-band, 800-mW power-amplifier MMIC devel-



5. MMIC fabrication. Fabrication of a GaAs IC starts with deposition of a n-layer followed by etching of mesas (top). Then ohmic contacts, Schottky gates, and first-level metallizations are placed on the substrate. Next, capacitor top plates and air bridge interconnects are formed. Finally, vias are formed and the wafer backside is plated.

oped at TI has 27-dB gain and a 1-dB bandwidth from 9.2 to 10.5 GHz (Fig. 7). This unit is 5.75 by 1.63 by 0.15 mm and GaAs FETs with gate widths of 0.3, 0.3, 0.6, and 1.5 mm are used in the first through fourth stages. Networks of inductors and MIM capacitors are used to provide 50-Ω input and output impedances and the appropriate impedances for interstage matching. The drain bias is brought to the FETs through the line running along the upper side of the chip and the gate bias through the line along the lower side.

The FETs are the multifinger structures along the center of the chip and the capacitors are the large squares and rectangles. The eight very large pads are 30-pF shunt capacitors to ground. The groundplane is brought to the capacitor bottom plates through etched vias to the back of the chip, which also ground the FET sources. Only four wire bonds are required to operate this chip—drain bias, gate bias, rf input, and rf output. The gates are approximately 0.75 μm long and are defined by electron-beam lithography. This chip, with less than 10 mm^2 area, has the performance of a much larger hybrid amplifier.

At the coming 1985 Institute of Electrical and Electronics Engineers' Microwave and Millimeter Wave Monolithic Circuits Symposium, scheduled for June in St. Louis, Randall Lehmann and David D. Heston of TI will discuss an X-band monolithic series-feedback low-noise amplifier (Fig. 8). This is the first reported e use of series feedback in an MMIC to achieve state-of-the-art X-band performance.

The series-feedback element (an inductor in the source lead of each FET) is fabricated on the semi-insulating GaAs substrate at the same process step as the rf transmission lines and the bottom plates of the MIM capacitors. This unit has demonstrated a 1.8-dB noise figure with 30-dB gain at 10 GHz.

Although IC designers have many silicon foundries to choose from, companies whose engineers design custom analog MMICs have only two GaAS foundries to choose from—Adams Russell Semiconductor Center, Burlington, Mass., and Tri Quint Semiconductor Inc., a subsidiary of Tektronix Inc., Beaverton, Ore.

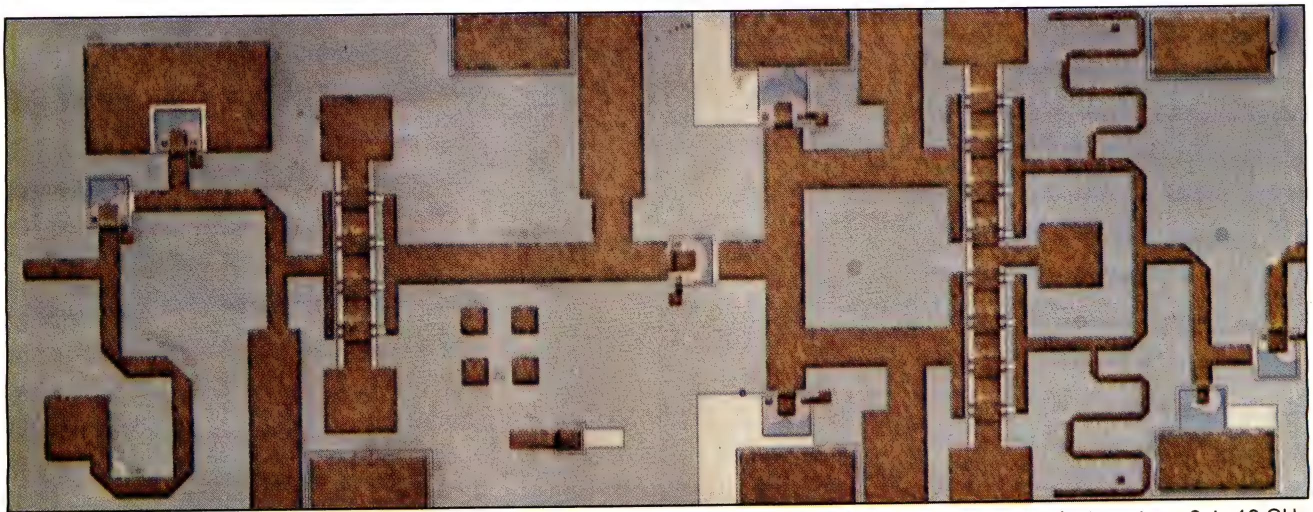
Adams Russel's process line is based on 2- and 3-in. wafers, direct ion implantation, deep-UV contact lithography (for 0.5- to 1-μm gate lengths), lift-off electron-beam metallization, plasma-deposited silicon nitride for capacitor dielectrics, air-bridge interconnects, and automated dc/rf testing.

Adams Russell has made amplifiers of all types (low noise, power, and transmit/receive), rf switches, and phase shifters for operation at from 1 to 18 GHz and up to 1-W power level. Twelve weeks is a typical turnaround from submission of input data to wafer.

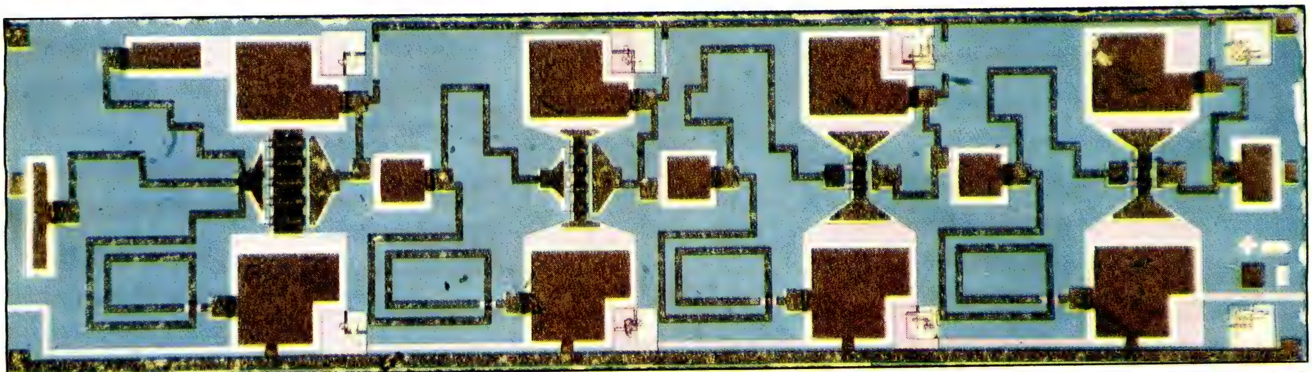
Tri Quint, with a process useful to 12 GHz, basically will make the same range of devices as Adams Russell. Usually this 11,000-ft^2 foundry uses a standard 1-μm gate length on its MES FETs based on direct-step-on-wafer optical lithography. For special parts, a Karl Seuss contact lithography system can expose 0.5-μm gate lengths.

Unlike Adams Russell, Tri Quint's policy is to avoid the use of microstrip if possible, because it requires vias that use up chip real estate. Instead, its approach is to use coplanar transmission lines or the distributed (lumped) elements. Above 10 GHz, distributed elements must be used on MMICs.

At Tri Quint, a customer can have his masks made outside or he can have them done at Tektronix's electron-beam facility. It is a customer's responsibility to check his circuit and to



6. X-band IC. Future transmit/receive modules for radar and electronic-countermeasures phased arrays may use the two-stage, 8- to 12-GHz GaAs MMIC developed by Westinghouse Electric Corp.'s Defense and Electronics Center. The unit puts out 1 W with 9-dB gain. The chip measures 2 by 5.2 by 0.1 mm with 3.6 mm of gate periphery and contains 23 vias and 27 air bridges.



7. Four of a kind. On this monolithic X-band FET power amplifier from Texas Instruments, four FETs are squeezed onto a 5.75-by-1.63-by-0.15 GaAs substrate. The drain of each stage is biased through a two-turn spiral inductor-capacitor combination to a drain bias line.

follow Tri Quint's design rules, which are described in an 800-page design manual. Adams Russell has a three-day course on GaAs IC circuit design and processing that ends with a customer designing and laying out an actual circuit.

Much work must be done before analog MMICs move out to the production floor. This was pointed out in two papers given at a session on the status of miniature microwave circuits at the recent Electro/85 in New York. In one of these papers, William H. Perkins of General Electric Co., Syracuse, N.Y., discussed manufacturing disciplines for GaAs MMICs, while in a second paper, James E. Degenford of Westinghouse Defense Electronics Center, gave his views on the current status and future trends in GaAs MMICs.

Work in R&D labs

Perkins notes that manufacturing of MMICs has been limited mostly to research and development laboratories, with little thought of the disciplines required for high-volume production. He further points out that there are three major concerns in obtaining a good MMIC production design—the design must be positioned about the center of the expected material and process parameter distribution; chip sizes must be reduced; and FET design must be optimized.

Yield is highly dependent on gate length. In fact, variation in gate length has the most impact on yield and therefore selecting the lithography method for production will be critical. For geometries of 0.5 μm or less, electron-beam lithography is currently needed to achieve the required tolerance of ±10%. To achieve adequate production yields, this accuracy will be required along with rapid wafer-handling capability.

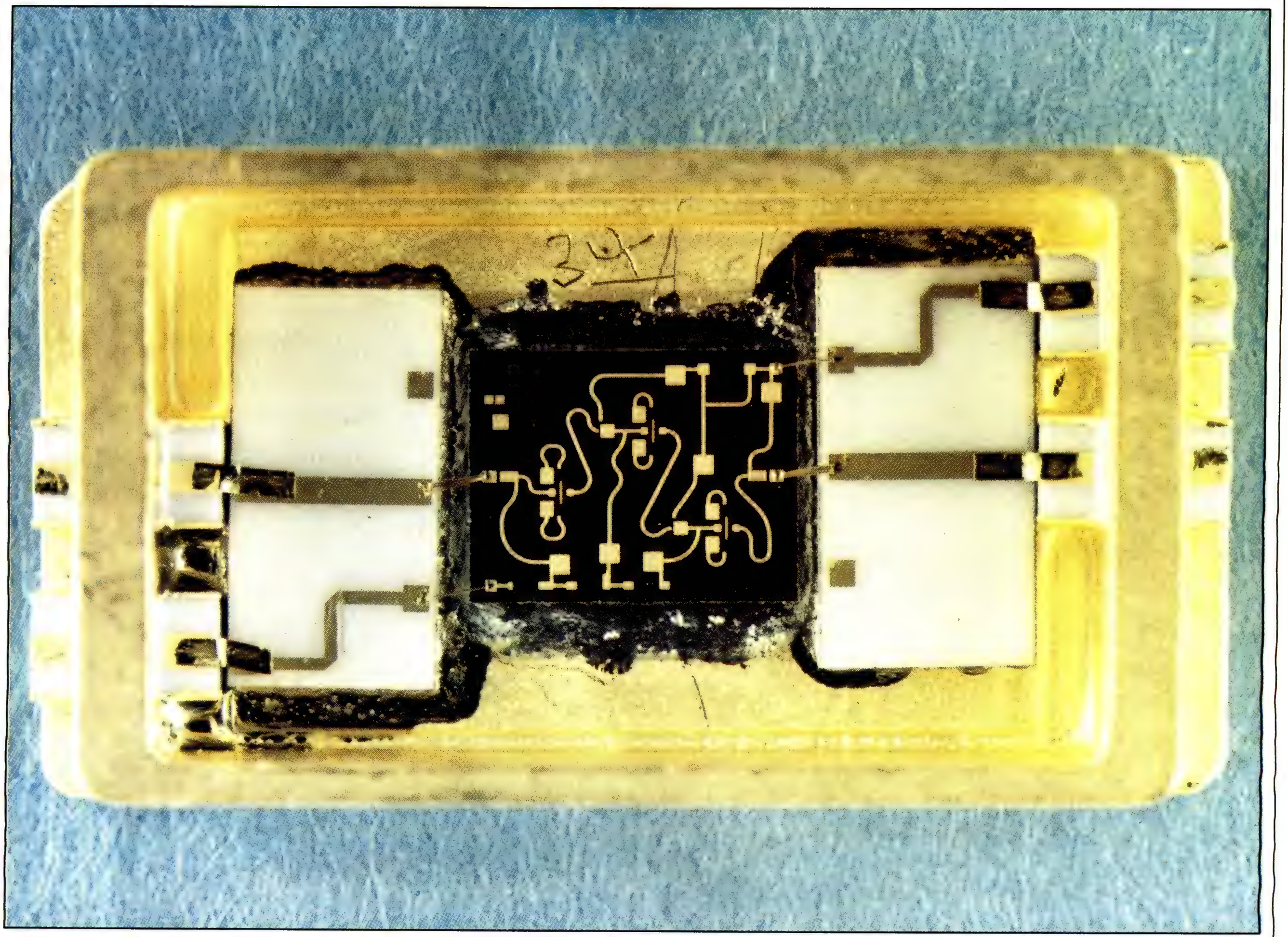
Another major concern is chip size, because many current R&D designs are too large to manufacture in production. The author cites the cases of a transmit/receive phase shifter/switch that measured 7.6 by 7.9 mm and is being redesigned in a lumped-element configuration to reduce its size fourfold.

Degenford's paper notes that though efforts to further increase power and bandwidth and improve noise performance are sure to continue, clearly identified system needs for the 1990s are dictating that high-volume manufacturing issues be addressed during the next few years. Major thrusts in the area of manufacturing methods and technology are planned; key areas of investigation are materials and processing uniformity, and high-volume testing and packaging.

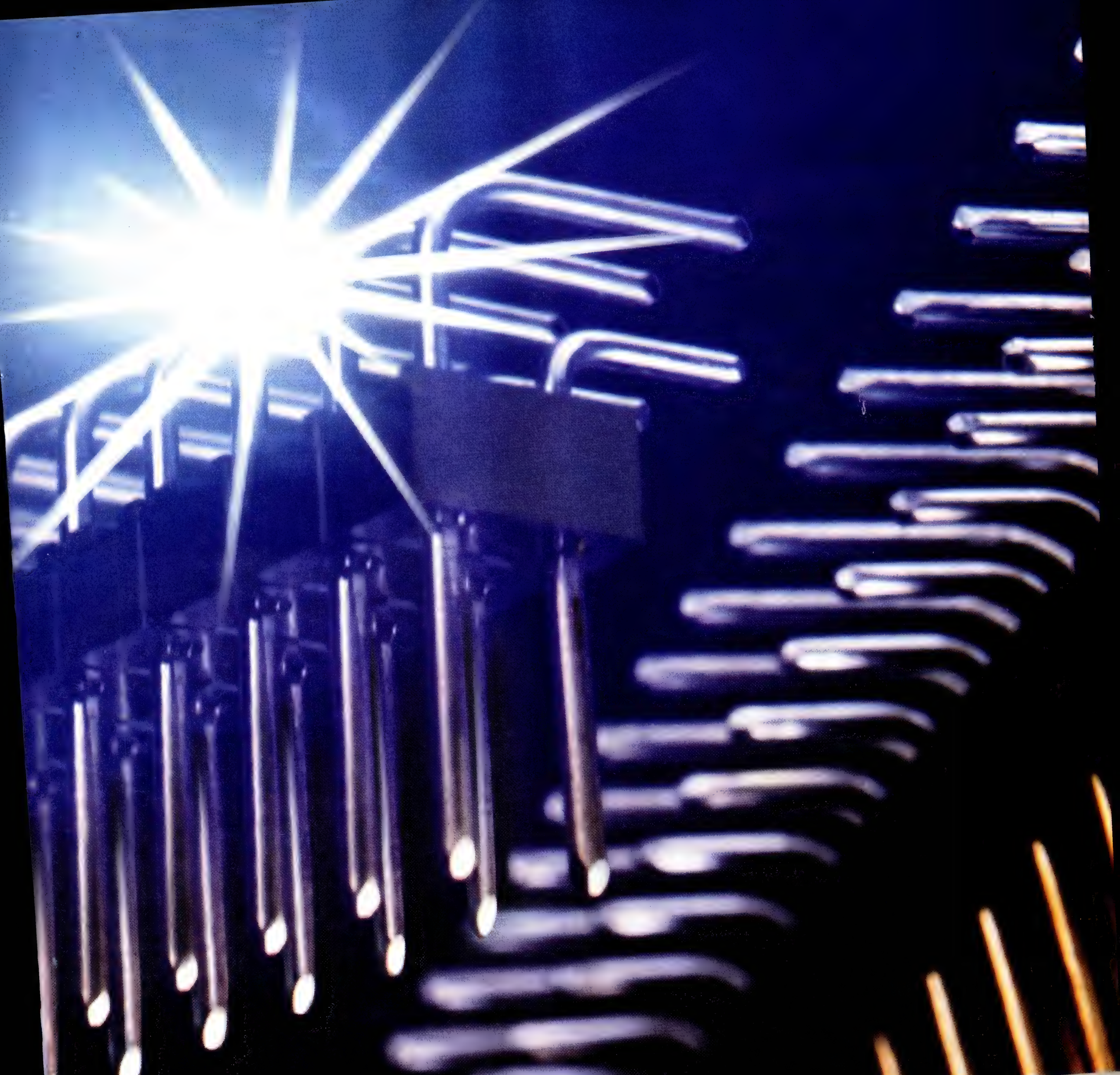
The author points out that in material and processing uniformity, a critical requirement will be the establishment of a comprehensive data base to allow the correlation of wafer-characterization measurements with finished chip quality. The processing of a large variety of wafers and examination of the resulting data will allow the distinguishing of good and bad wafers in terms of material-growth technique, wafer-surface characteristics, and active-layer formation.

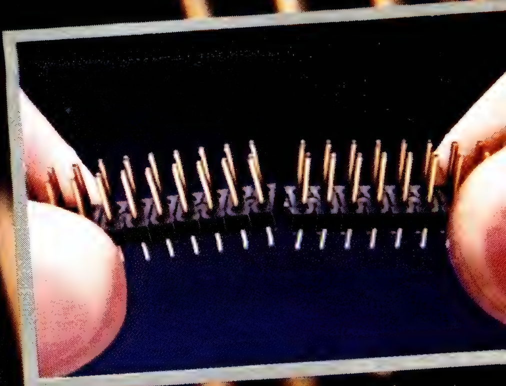
In the testing area, the author says that an important issue will be automated high-speed dc testing and on wafer rf probing to ensure the subsequent handling and mounting only of chips that meet rf specifications.

Packaging-technology issues, the author continues, must also be met. For instance, one of the most critical areas is handling of the thin, fragile GaAs chips. This is currently a manual operation because robots do not have the tactile ability to handle the delicate parts. For large-volume production, a packaging concept will be needed to allow for the efficent handling of these chips and subsequent assembly into MICs.□



8. Microwave feedback. A three-stage low-noise X-band amplifier that has been developed by Texas Instruments is one of the first MMICs to use series feedback to achieve a low noise figure. The unit is mounted in a test fixture with matching microstrip substrates.





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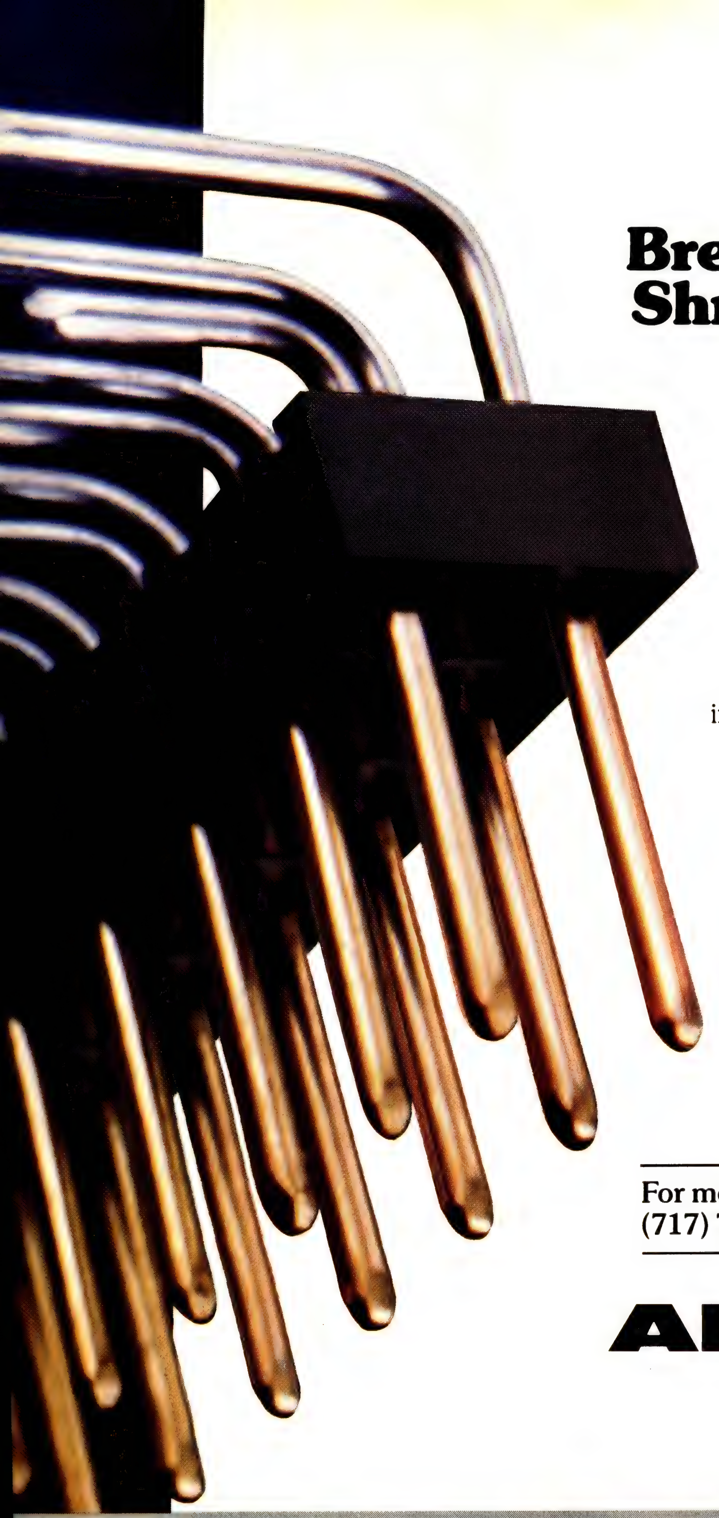

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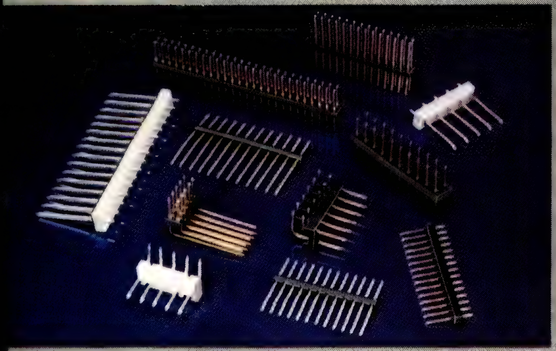

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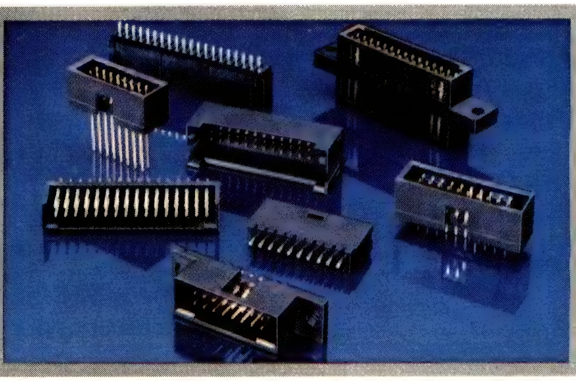

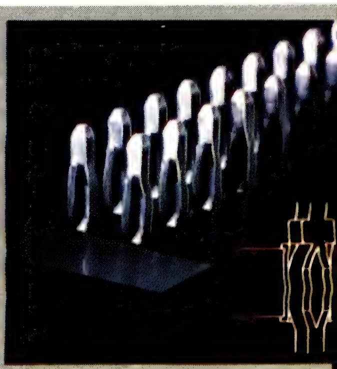

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CUSTOM-IC CONFERENCE REFLECTS SIGNIFICANT GAINS FOR SYSTEM DESIGNERS

by Samuel Weber

NEW TOOLS, MODELS, AND PROCESSES SERVE TO BOOST THE VERSATILITY OF APPLICATION-SPECIFIC ICs

Concerned as it is with the fastest-growing segment of the semiconductor industry, it's not surprising that the Custom Integrated Circuits Conference is growing commensurately in size and importance. Attendance at the seventh edition of the conference, convening this week in Portland, Ore., is expected to go well over 1,200, last year's figure and itself a record. What's more, the program will feature 120 papers selected from more than 220 submitted from around the world.

These numbers don't quite put the CICC in the same class as its older counterpart, the International Solid State Circuits Conference, but the rate of growth of the upstart CICC, which emphasizes such topics as computer-aided design and associated tools, standard cells, gate arrays, and full custom designs, attests to the mounting attention being paid to the custom and semicustom segment of IC technology.

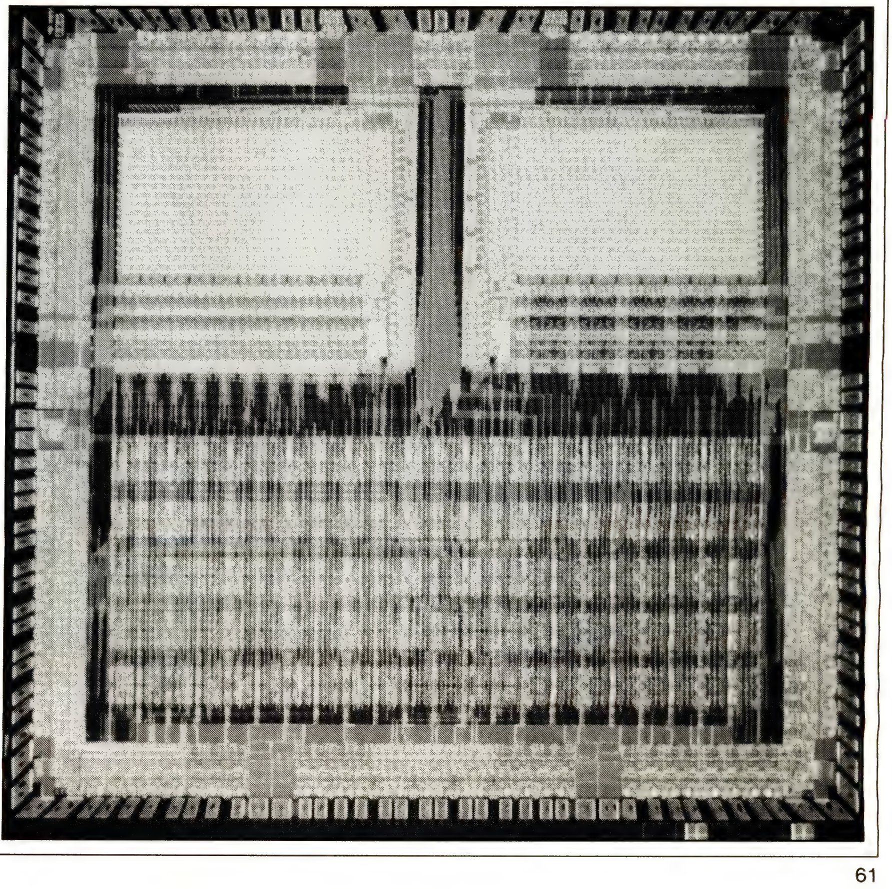
Unlike the 1985 ISSCC, where Japanese papers predominated, only 4% of papers submitted to CICC came from Japan, and U.S submissions totaled 70%. This seems to confirm the view that the Japanese are weak in a software-dominated technology that requires greater interaction with customers.

Nevertheless, the conference kicks off with a session on gate-level design headed by a group from NEC Corp. Their paper presents a unique technique that combines the fast design turnaround of gate arrays with the economy of scale associated with standard cells. The technique accomplishes this by creating a standard cell out of an imaginary pre-proven CMOS gate array with a maximum density of 17,000 gates. The internal cells and the input/output buffer cells of the imaginary gate array can be automatically placed and routed using a layout program called Cocktail. Inputs to Cocktail comprise block diagrams, lead-frame libraries, and a netlist of macro libraries.

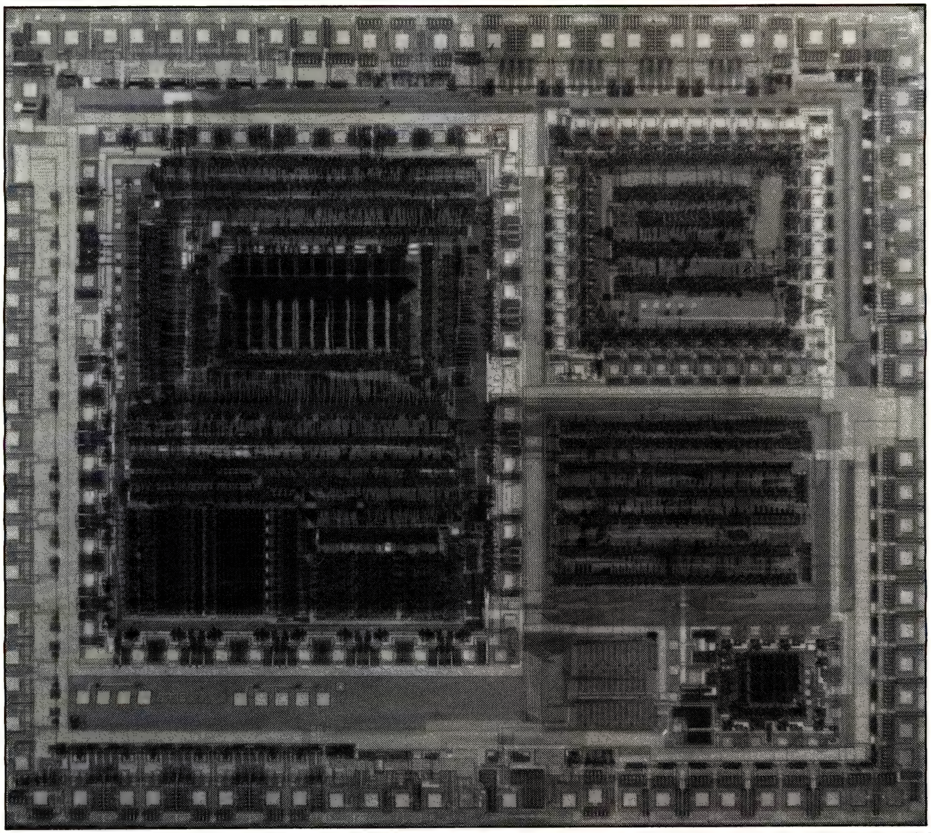
When the desired function is laid out using the available gates on the imaginary array, an automatic compaction program eliminates all the unused cells and unrouted channels to reduce the chip size to a minimum. The system determines the smallest rectangular array of internal cells, external I/O cell areas and appropriate power and ground network, and other mask patterns for manufacturing. The result is a standard cell with significant reduction in chip size over the same design done on a conventional gate array. Applying Cocktail to a 2-μm CMOS 2-K gate-array design resulted in a chip reduced in size to 70.9% of the original area. Similarly, a 4-K array design was reduced to 73.5%. A 2-ns gate delay and 250-MHz toggle frequency has been obtained from the 2-K standard cell.

Another modification of the standard-cell approach was applied by a team at AT&T Bell Laboratories, to develop a dynamic-random-access-memory controller capable of handling 16 megabytes of memory using 1-Mb DRAM chips. The controller was developed to conform to the synchronous protocol of AT&T's home-grown WE32100 32-bit microsystem family.

The floor plan of the controller chip was partitioned into eight functional groups called superblocks. Relative positions of the superblocks on the chip were determined primarily by requirements to minimize clock skew. When the layout of a superblock was completed, circuit parameters were extracted by HCAP software and layout validity was verified before



1. On-chip RAM. The combined ECL-TTL array from Applied Micro Circuits Corp. contains 1,600 equivalent logic gates and 1,280 bits of random-access memory. Memory is divided into two modules independently accessible in a dual-port mode. Simplified testing at the system level is one unique advantage.



2. Microengine. Toshiba's superintegration technique has resulted in a chip that includes a CMOS version of the Z-80, interface circuits, clock generator, and 3,500-transistor custom macrocell.

timing simulations were performed. Any changes required by timing problems were then accomplished by adjusting the transistor widths of those components in critical timing paths. This departs from the typical standard-cell design process where adjustments can only be made by adding more gates for more drive capability, which would require the entire superblock to be rewired.

The new technique resulted in a very rapid design turnaround. Seven of the eight superblocks were designed in less than seven weeks, and there was a reduction of 80% in manpower compared to the same design using a hand-packed gate-matrix method, although a 10% to 20% area penalty was incurred in each superblock. The DRAM controller chip was successfully implemented with a 1.74-μm twin-tub CMOS technology. Layout of the required 12,500 transistors was completed in less than four months and error-free silicon was obtained from the first mask set.

Macrocell designs

In a session devoted to macrocell-based design, Rodney Matsumoto of Applied Micro Circuits Corp., San Diego, will describe a high-speed bipolar logic array containing 1,600 gates of both TTL and emitter-coupled logic and 1,280 bits of random-access memory (Fig. 1). Fabricated with a 3-μm oxide-isolated process, the chip achieves a 275-ps gate delay and a 5-ns typical delay time. The RAM section of the chip is configurable to a variety of word sizes ranging from 1,280 bits by 1 bit to 32 by 40 bits. The basic RAM area contains a memory core with standard address interfaces. The memory core is divided into two 640-bit modules, permitting independent utilization of each module or configuration into a dual-port mode.

The column address decoding and the data I/O porting are made variable. The 640 standard ECL storage cells are arranged as 16 rows of 40 elements each. The number of sense amplifiers to which the memory data is routed has been left uncommitted in the base design. Instead, a data-word configuration matrix is used to perform the final hookup, allowing each application to be customized with respect to the data word size.

A dual-mode feature is available for this chip, dubbed the QM1600, permitting two independent sets of input signals to access each RAM module. One port accepts off-chip control signals and the other accepts signals from the on-chip logic or I/O cells. Among other advantages, this dual-mode feature simplifies testing at the chip and system levels.

At the chip level, the RAM modules can be tested independently from the internal logic array, allowing standard RAM-test procedures to be used without extra overhead logic. On the system level, the RAM can be preloaded with selected test vectors before exercising the logic portion of the chip. The resulting data can be placed back into the RAM and read out by the system.

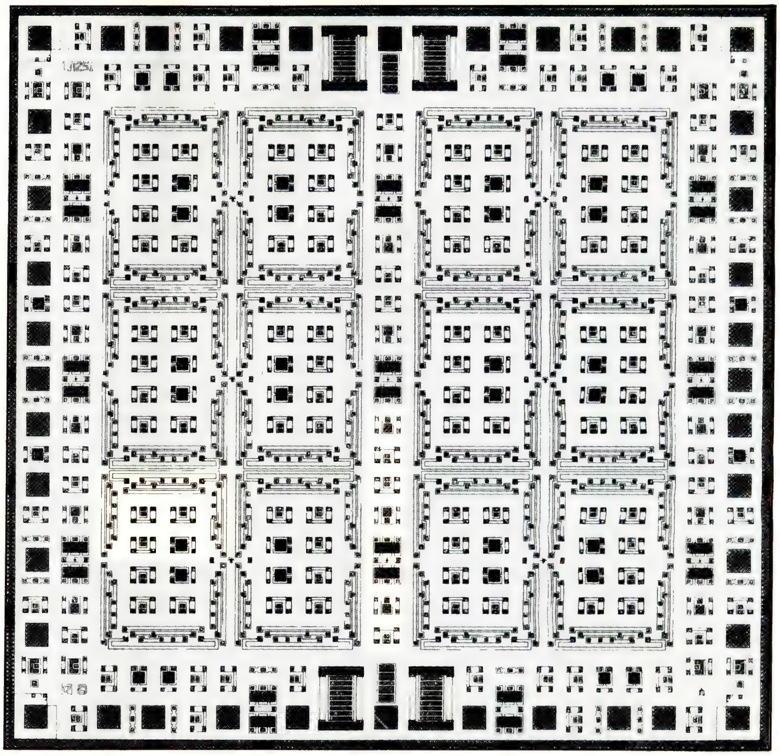
As with other arrays in their product line, Applied Micro Circuits supports the QM1600 with a full set of CAD tools, including a complete line of logic macros for use with many of the popular engineering work stations. There is also a set of predefined RAM macros to simplify the selection of the desired RAM configuration.

Two technical teams from Toshiba Corp.'s Integrated Circuit division and Toshiba Micro-Computer Engineering Corp., Kawasaki, Japan, joined hands to develop a method of designing very large-scale-integration chips with a technique they call superintegration. The method they will describe this week is based on using standard products such as microprocessors and associated peripheral circuits as large standard cells called supermacrocells. To customize a design for various applications, another set of custom supermacrocells was designed with a CAD software tool called Taplas, for Toshiba automatic pattern layout and analysis system. These supermacros can be combined on a single chip and interconnected by double-layer metal to implement a VLSI function.

Superintegration has been applied to a microengine chip (Fig. 2) comprising three standard CMOS supermacrocells (Z-80 microprocessor, programmable peripheral interface, and clock generator) and a 3,500-transistor custom array using 2.6-μm design rules—all on a chip of 7.7 mm^2. It took only four weeks to complete the design through the mask data-base generation phase, and the first sample met all specifications.

The superintegration concept closely resembles one that will be advanced by a group from LSI Logic Corp., Milpitas, Calif. They call their approach structured arrays. It consists of a family of 2-μm arrays of up to 6,500 logic gates and a group of custom-designed cells called Megacells. The latter group comprises various RAM sizes from 2- to 8-K, a 32-K read-only memory, programmable logic arrays, multipliers, and various 2900-family bit-slice functions. These arrays can be personalized by metallization for fast turnaround.

The nature of analog or linear ICs makes it difficult to use the array or standard-cell approach in their design. Irregular topology and absence of so-called standard building blocks militate against the development of CAD tools like those available for digital IC design.



3. Custom linear array. The modular structure of these linear arrays from Linear Technology Inc. overcomes some of the difficulties of semicustom linear-circuit design. The arrays are organized around two modules (in color), each of which contains a variety of components that can be interconnected by a single metal mask.

Peter King of Linear Technology Inc., Burlington, Ont., Canada, points out that because of the lack of suitable CAD tools, the design of semicustom linear circuits calls for a significant grasp of IC design and layout at the subcircuit (transistor-resistor) level. System designers, he says, lack the skills and the confidence to undertake their own designs, and thus shun the semicustom route.

King and his colleagues have developed a new series of linear arrays, however, with an improved topology that overcomes many of these limitations (Fig. 3). Components are structured into a series of modules and submodules that are repeated symmetrically across each array. This modular structure enables the arrays to support a comprehensive library of subcircuits, with interconnections defined by a single metal mask. Each subcircuit can be placed or oriented in a number of array locations, and the subcircuit layouts are transportable from one array to another also.

Linear Technology's arrays, embodied in a series called Modula (for modular uncommitted linear array), are organized around a regular core section incorporating one of two available modules. Each module contains groups of components, including a variety of transistors and resistors of various values. The two basic modules are repeated across the array in a regular, symmetrical arrangement to form a series of large modules. Each of the modules, large and small, is repeated at a large number of locations across the core of the array. Subcircuit interconnections can be defined by using a single metal mask to match each different component module. The arrays have all been designed on a regular grid system. The user inserts the required interconnection tracks by simply drawing lines between clearly defined grid points marked on a layout sheet or CAD system.

Linear mosaic

Another, similar approach to the analog semicustom design problem is embodied in a technique advanced by Micro Linear Corp., San Jose, Calif. P.A Crola and D. Culmer of that company will describe a novel monolithic bipolar array that uses a concept called a linear mosaic.

In this approach, an identical grouping of devices (called a tile) is repeated in a regular manner on the chip. The array contains 10 main programmable tiles, 8 peripheral auxiliary tiles, 2 standard cells, and 28 bonding pads, all on a die of 19,000 mil^2. A library of macrocells, which are formed from various tile components or from the two standard cells, can then be used along with an automatic cell placement and routing routine to perform analog LSI design on a rapid turnaround basis. The methodology, according to Micro Linear, is particularly adaptable for use with Daisy Systems Corp.'s Logician and Gatemaster work stations.

The ideal custom design methodology, according to proponents, is synthesis, a technique in which a computer derives a complete design down to at least the logic level from a high-level functional description. Though a variety of programs have been developed to achieve synthesis, each generally falls short of the ideal in some respect, either in speed of operation, degree of optimization, or flexibility. This question is being dealt with at the conference in a session that includes two tutorial papers.

One is an overview of silicon compilation, a synthesis technique that translates system specifications into very large-scale-integration masks through software. Former Bell Laboratories scientists Misha R. Buric and Thomas G. Matheson, now of Silicon Design Labs Inc., Liberty Corner, N.J., will review the current state of the art of silicon compilation.

They divide the process into three design levels: functional, which specifies system behavior; structural, which specifies the architectural components and their interconnections; and geometric, which specifies the physical properties, such as floor plan, cell placement, and mask layout. This last step is usually accomplished by a program called a module generator.

The authors will review the existing approaches to these three design levels and discuss their own contributions to the technology. One is a new procedural VLSI design language called L, which can capture both the structural and the geometric aspects of a layout simultaneously. The company has also developed a collection of tools designated GDT, for generator-development tools. The collection includes the L compiler with its routers, the L graphical editor with an interactive rule checker, and a mixed-mode switch/logic simulator.

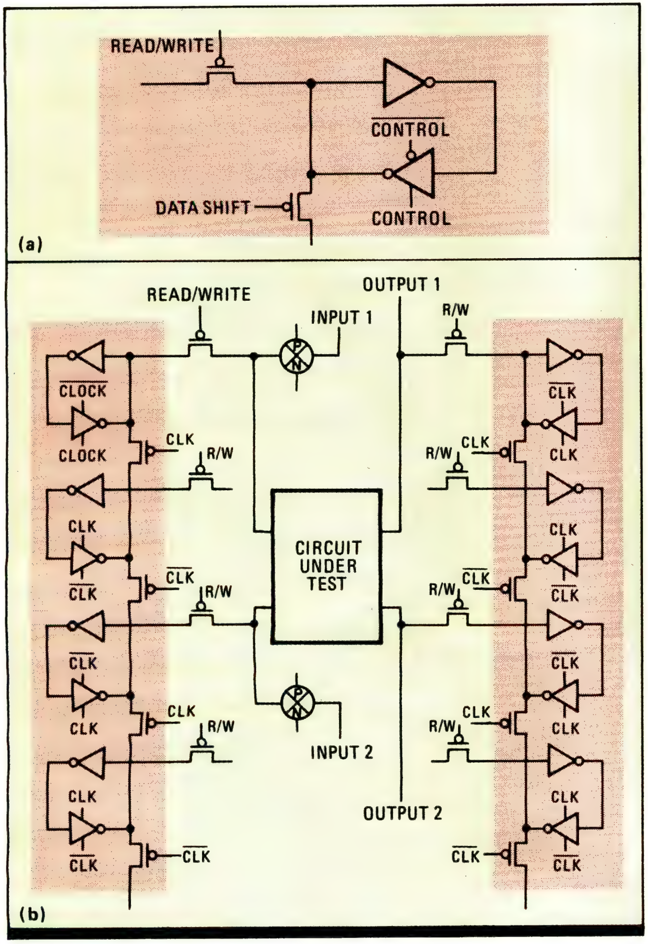
At the center of GDT is L, which can capture hand-crafted layout cells, transistor schematics, block diagrams, and generator programs, all of which can be edited and simulated together in a common environment. At GTE Laboratories Inc., a silicon compiler dubbed Silc is being developed that will produce mask specifications from an algorithmic circuit description written in a Lisp-like language called Shawl.

Silc is aimed primarily at automating the design of telecommunications circuits with the predominant technology of dynamic CMOS. Complex circuits such as programmable logic arrays, adders, comparators, incrementers, counters, timers, and sequencers are designed using precharge-discharge techniques. Silc synthesizes a circuit by using specialized generators to manipulate parametrically the well-defined circuit elements called leaf cells. Typical leaf cells are contacts, vias, n or p transistors, inverters, flip-flops, and so on. The Silc circuit generator combines these to create functional blocks. A Silc chip is designed as a collection of finite-state machines formed from the leaf cells functioning in parallel.

According to GTE scientists C.P. Rosebrugh and J.H. Vellenga, Silc is aimed at system designers who may have little knowledge of VLSI circuit design. The Silc system has been only partially completed. The Silc parser, logic minimizer, extractor, and functional simulator are in place, and are being used at GTE to design gate-array and standard-cell chips. Still under development are circuit generators, the general block-placement algorithm, and the router. Also being developed at GTE are automatic testability design functions and automatic test-generation capabilities for Silc. Full operation is forecast by the end of 1985.

An actual completed system design using silicon compilation techniques will be described by Gail H. Allwine of Gonzaga University, Spokane, Wash. Senior and graduate students at Gonzaga designed a complete multichannel analog data-acquisition system for a remote air-monitoring application. Components of the system include an analog multiplexer, an analog-to-digital converter, and serial receive/transmit sections for connection to a terminal or computer. Combining digital and analog cells on one 175-by-280-mil chip implemented in 3-μm double-poly CMOS, the design work was done on a Concorde IC design system developed by Seattle Silicon Technology Inc.

Concorde software contains menu-driven compilers for configurable generation of a number of digital building blocks including various medium-scale elements, PLAs and standard logic arrays, memory, and pad rings. The ADC and analog multiplexer were available as fixed, nonconfigurable cells. Two computer systems were used: a VAX 785 and Valid Logic Scaldstar work station. The system was originally intended for remote monitoring of 13 air-quality transducers, all having standardized analog voltage outputs with very slow time variation. When connected by a serial data path to a personal computer, however, the system essentially forms a remote-controlled 16-channel data logger of general application.



4. Testing, testing, testing. Incorporated onto a gate array, General Electric Co.'s latch cell (a) not only provides memory capability to the logic array, but is easily configured into a logic scan register (b) that is used for simplified built-in test.

As VLSI chips become more complex and dense, the problem of on-chip testing also becomes more important and more difficult. At General Electric Co.'s Custom Integrated Circuits Department, Research Triangle Park, N.C., J. Douglas Milner and John J. Watters have designed a special cell, to be included in CMOS gate arrays, that functions as both a memory cell and a testability cell.

The cell design features a versatile latch structure that is placed in the routing area between columns of internal gate-array cells. In addition to added memory capability, the cell provides a dedicated, bidirectional shift path between adjacent latch cells. The latch cell is readily configured into a logic scan register, allowing circuit nodes that are otherwise difficult to test to have their logic states loaded into a register and shifted out during test. The latch cell is also easily combined with nearby gate array cells to form linear-feedback shift registers for test-vector generation and signature analysis.

For use in a memory function, the latch cell can easily be applied to scratchpad or random-access registers with unique bidirectional shift capability. The cell is designed for use with GE's third-generation 1.25-μm CMOS process. A test chip for the process is scheduled for completion in 1985, aimed at demonstrating the capability of the latch cell and providing insight for the development of the 1.25-μm family scheduled for commercial release in the first half of 1986. The latch cell is a simple feedback structure with two single p-channel transistors serving as the bidirectional data-shift path and the read/write path for memory application (Fig. 4a). The four-transistor tristate inverter is constructed from wide p- and n-channel devices to provide latch feedback and drive for memory and shift operations. When the latch circuit is used as a test register (Fig. 4b), the primary inputs of the circuit under test may be disconnected using two transmission gates. Data in the left-hand register is then supplied as test inputs, and the circuit outputs are loaded into the right-hand register and shifted to a test pin.

Designing CMOS for testability

How to design CMOS circuits for effective testability is the subject of a unique study being conducted at IBM Corp.'s General Technology Division, Essex Junction, Vt., by Pamela Moritz and Laurice Thorsen. They point out that CMOS circuits present unique testing problems because certain defects in CMOS chips, such as shorts and opens, can manifest themselves in ambiguous ways, other than stuck faults. (Stuck faults occur when a circuit's input or output is shorted to V_{DD} or ground, thus stuck at logic 1 or 0.) A stuck fault is relatively easy to detect by applying certain test patterns. Short circuits between devices or open circuits between a device's source and drain require other methods.

In their paper, Moritz and Thorsen show a number of ways in which the design and layout of CMOS circuits can affect the testability of faults, particularly open faults. IBM has developed an automatic test generator to generate test sequences for such faults, since studies show that open faults could be a significant quality factor. It was found that a considerable increase in central processing unit usage is required to generate pattern sequences for testing for opens compared with stuck-fault testing. Tests should give more insight into whether stuck-fault test generation is adequate for testing CMOS circuits. Power-supply current is being monitored to determine whether CMOS shorts can be detected reliably in this way.

In addition to the above topics, the conference program also features reports on custom and semicustom designs for such specific applications as data acquisition and signal processing, telecommunications, and imaging and sensing. There is also a session on the increasingly important topic of gallium arsenide digital ICs. ☐

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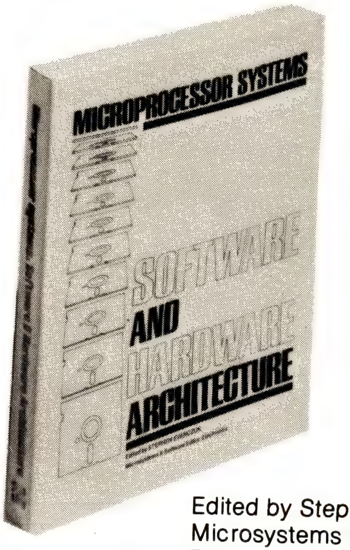

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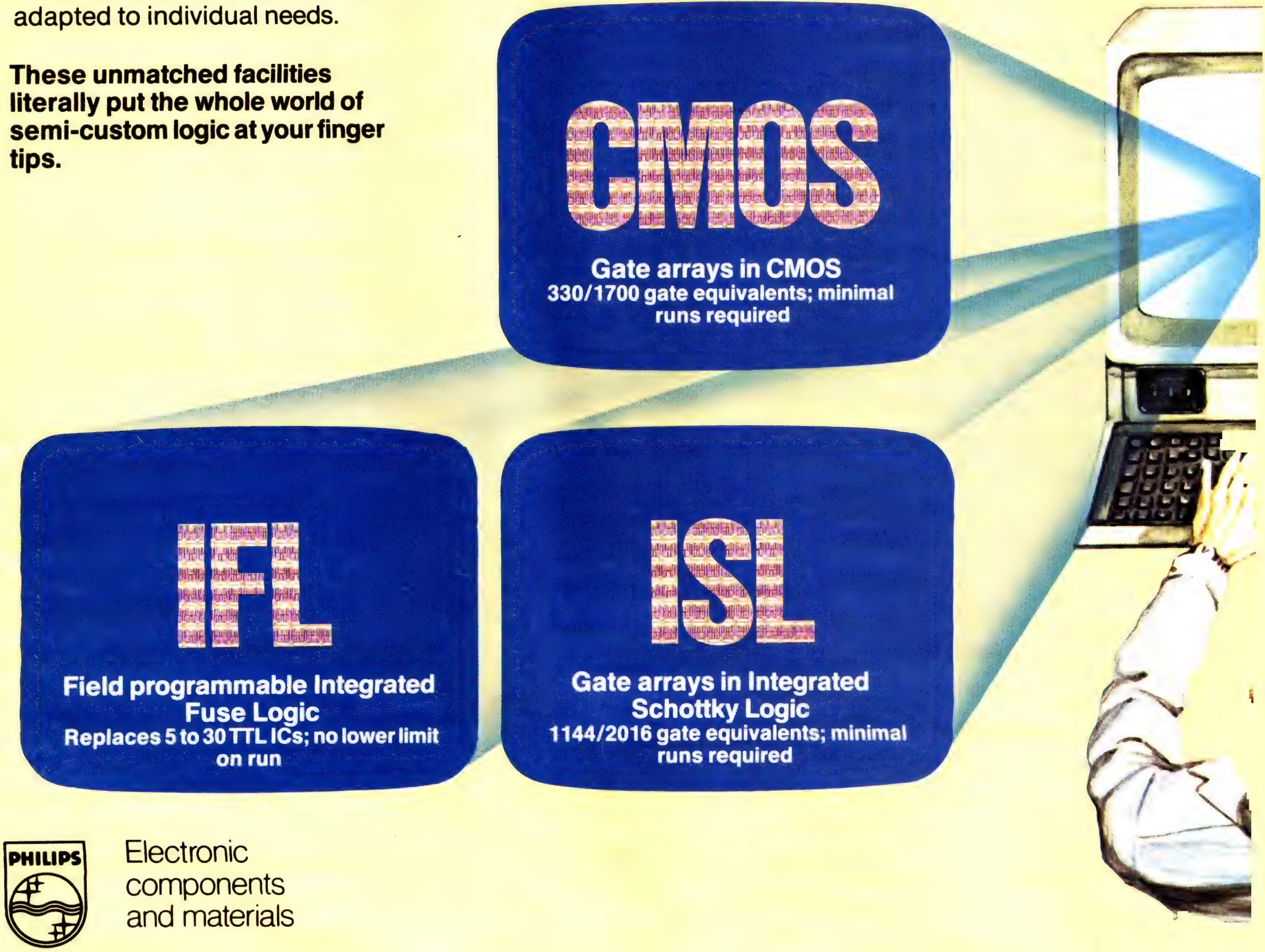
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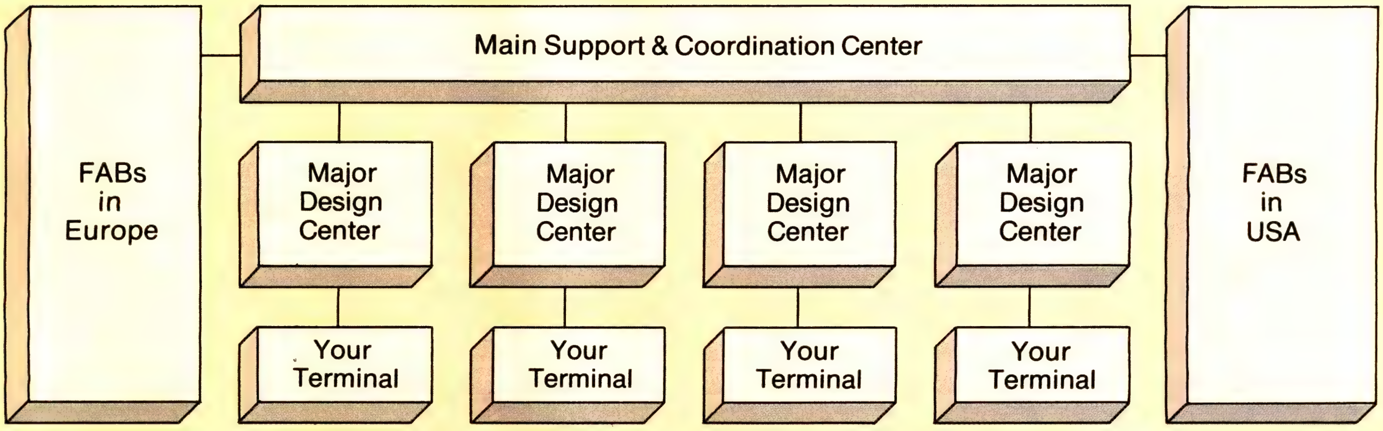

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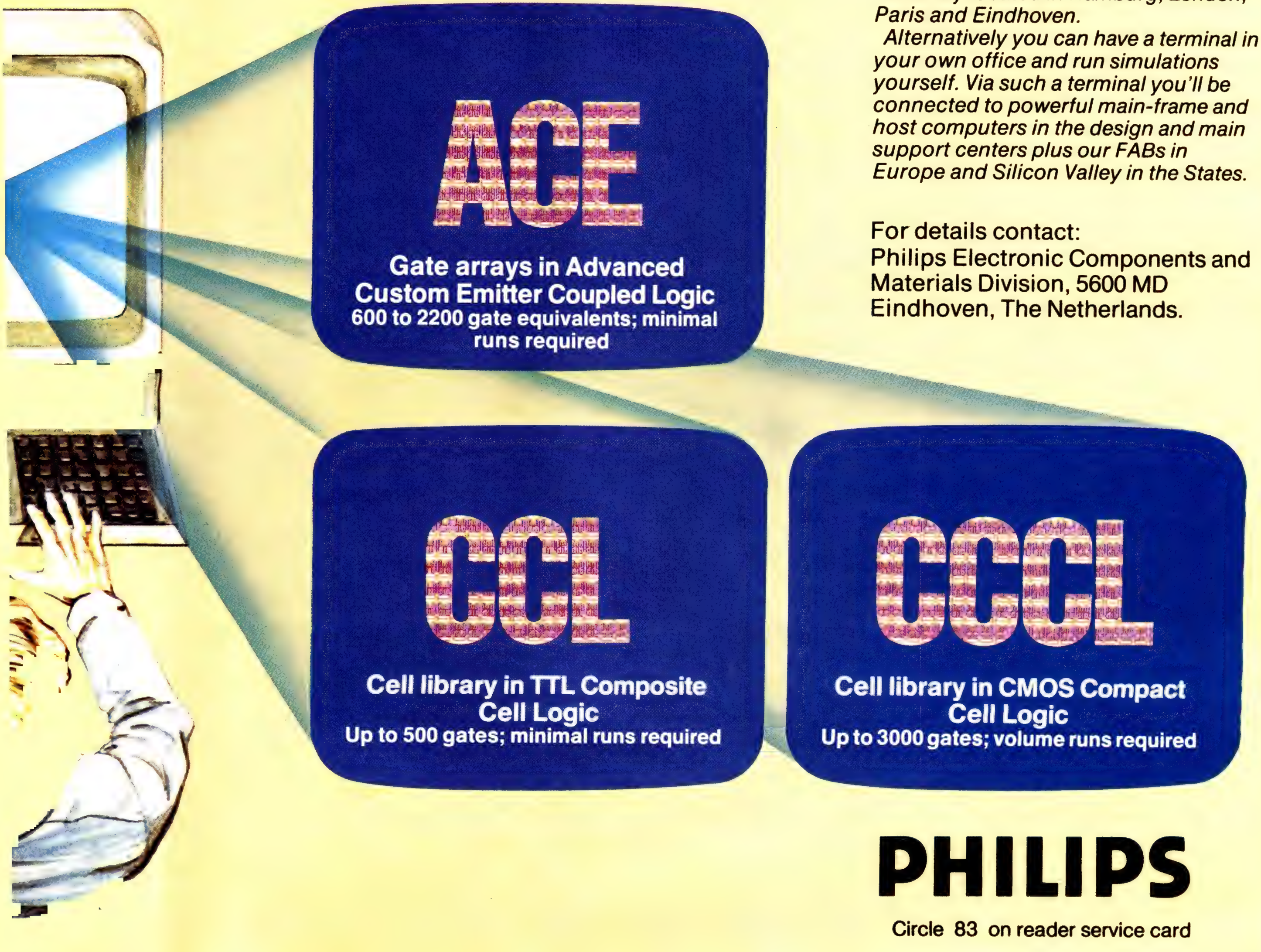

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MULTIFUNCTION GEAR EASES COMMUNICATIONS BOTTLENECKS

by Steve Zollo

Now that the growth of the personal computer market has leveled off—nearly everyone who needs a computer already owns or uses one—attention has turned to making the best use of computers. A trio of communications-related multifunction products that do just that turned up at Comdex/Spring in Atlanta.

Carterfone Communications Corp. unveiled a communications controller that combines the features of an electronic mailbox, intelligent modem, and integrated communications software. Hayes Microcomputer Products introduced a multifunction productivity device that provides print and communications buffering, I/O switching, and port expansion. On the low end, Quadram Corp. took the wraps off its Microfazer II, a beefed-up intelligent print buffer.

The three products, despite several differences, offload printing and some communications functions from the personal computer, freeing it for other tasks. But all three products add new dimensions to the printer-buffer concept. That market was only 15,000 units strong last year but is projected to grow at 20% to 25% a year, says Tim Riggins, an analyst with Future Computing Inc. But Riggins says that Hayes' marketing force could increase the size of the market by focusing attention on buffers and their capabilities.

Typical personal computers pass data around at 19,200 b/s but modems for personal computers can accept data only at 300, 1,200, and 2,400 b/s and printers and plotters take in data at 300 b/s. Because the computer is tied up while it waits for the slower peripheral to take in all of the transmitted data, printer buffers were designed to accept data at the computer's rate and then pass it on at the peripheral's rate.

Carterfone's Personal Communications Controller—and its accompanying PC/Reach II software—acts as a desktop front-end communications processor for IBM Corp. Personal Computers, PC/XTs, and PC ATs. Using independent CPU, input/output, and 128-K bytes of memory but operating in conjunction with the computer, the controller provides background and unattended communications processing, electronic messaging, terminal emulation, and multiple protocol support. "The introduction of the PCC marks the beginning of a new generation in personal computer communications," says Terry Schmidt, general manager of Carterfone's Information Systems Division. Available 30 days after it is ordered, the PCC is priced at $1,495.

Hayes' Transet 1000, which looks like its widely used Smartmodem 1200, in conjunction with a modem performs several tasks, including sending or receiving data over a modem while simultaneously directing a printer to produce hard copy. What's more, it can also act as a stand-alone 24-h mailbox: the Transet 1000 can receive and store data after the personal computer has been turned off.

The Transet 1000, an intelligent buffer for printing and communications, can compensate for the different speeds at which peripherals receive and process information. The unit can receive data from a computer at up to 19,200 b/s and then hold the data until it is sent at much slower speeds to printers or modems. The buffer can direct a printer to produce hard copy while the computer runs a program. It would take 4 min to transfer a 30-page file to a 2,400-b/s modem but only 27 s to transfer it to a Transet 1000. Printing a 17-page report would tie up the computer for about 10 min, whereas the transfer to Transet takes just 4 s.

Furthermore, the buffer can receive and store electronic messages or files while it sends other information to a printer. When a computer receives a transmission, usually it cannot be used for anything else.

The unit's communications features include time-date stamping, overflow control, and dynamic memory allocation. As a mailbox, its features include a log-on message as well as options for sending, scanning, and printing mail. The print capabilities include space compression, pagination, automatic page numbering, format control, collated printing of multiple copies, and time dating. "Anchor [Automation Inc.]'s Signal-

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man Mailbox combined with Quadram's Microfazer comes close to Transet's capabilities," says C.G. Betty, Hayes' marketing and sales vice president.

It also offers the XModem protocol to ensure data integrity and includes features to secure information from unauthorized use. Transet has 128-K bytes of memory, is controlled by a 68008 microprocessor, and also acts as a software-controlled A-B peripheral switch.

With two serial ports and a printer port, which supports both parallel and serial printers, Transet 1000 has the flexibility for several configurations. Two printers, or a printer and a modem, can be hooked to one computer port, or two computers can be connected to the Transet and share a single printer. Ports can easily be reconfigured with front-panel switches, ASCII commands, or the menu-driven utility software provided on a disk. The utility disk and a host cable, offered separately, are available in an accessory for the Apple IIc, Macintosh, and IBM PC. The Transet is priced at $399.

Quadram's Microfazer II, an intelligent printer buffer with capacities up to 2 megabytes of memory, offers parallel-to-parallel, parallel-to-serial, serial-to-parallel, and serial-to-serial transfer modes. The Microfazer eliminates delays caused by waiting for a printer to complete its task. It buffers print data without using up the computer's memory and takes over the printing task, so the PC can do other tasks.

Front-panel switches permit changing from one mode to another at any time and allow interfacing with a variety of output devices such as printers, plotters, and modems. The switching feature can be used in conjunction with the copy function, permitting one copy to be sent to a parallel device and another copy of the identical file to a serial device. Bit rate and mode are automatically configured when the unit is switched from one mode to another. The copy feature also permits a document to be sent to the Microfazer II while copies of another are still printing.

The Microfazer II supports bit rates of 50 to 19,200 b/s, with 7 or 8 b/character and with odd, even, or no parity bits. The Microfazer II, which comes as a stand-alone unit, sells for $269 with 8-K bytes of memory.

Carterfone Communications Corp., 1341 W. Mockingbird Lane, Suite 1100 W., Dallas, Texas 75247. Phone (214) 630-9700 [Circle reader service number 338]

Hayes Microcomputer Products Inc., 5923 Peachtree Industrial Blvd., Norcross, Ga. 30092. Phone (404) 449-8791 [Circle 390]

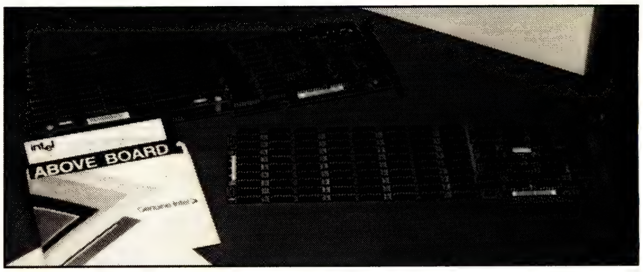
Quadram Corp., 4355 International Blvd., Norcross, Ga. 30093. Phone (404) 923-6666 [Circle 391]

Board brings IBM PC's memory capacity up to 8 megabytes

IBM Corp. Personal Computer memories can be expanded up to 8 megabytes beyond the 640-K-byte PC-DOS barrier with Above Board/PC and Above Board/AT, the result of a joint venture by Lotus Development Corp. and Intel Corp.

The two products are supported by Lotus 1-2-3 and Symphony programs, as well as by Framework from Ashton Tate. The combination of Intel hardware and Lotus software permits spreadsheets and data bases as much as 10 times the size currently possible. The device's Expanded Memory Manager software, a new disk operating-system driver, supervises the expanded memory and supports multiple applications.

Each Above Board/PC is configured with 2 megabytes of memory; up to four of the units can be used to expand an IBM PC's or PC/XT's memory by up to 8 megabytes. The Above Board/AT uses piggyback memory for a maximum capacity of 4 megabytes. RAM disk and print buffer capabilities for fast and flexible manipulation of large data bases can be user-installed through menu-driven procedures.



Above Board is sold in conjunction with Intel's 8087 and 80287 math coprocessors because, the company says, spreadsheet users who need the expanded memory will also typically need increased speed.

Above Board/PC retails for $395 with 64-K bytes, $595 with 128-K bytes of memory. Above Board/AT costs $595 with 128-K bytes and $995 for 512-K bytes. Above Board/AT with piggyback memory is priced at $295 with 128-K bytes, and $795 with 512-K bytes. Volume shipments of Above Board/PC are available immediately, but Above Board/AT will not be shipped until July.

Intel Corp., 5200 N.E. Elam Young Pkwy., Mail Stop TOC-03, Hillsboro, Ore. 97124. Phone (503) 629-7369 [Circle 340]

Single-board computer protects memory during power failures

Built around the manufacturer's 80C86 CPU, the HB-98605 single-board computer is Multibus-compatible.

The board is a low-cost solution for systems requiring battery-backed memory to protect against data loss caused by power failure. It uses low-power CMOS components, yet it is fully hardware- and software-compatible with the company's similar n-MOS version.

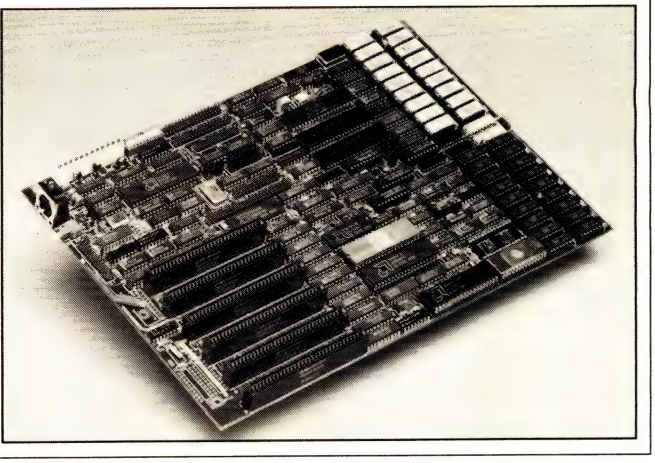
The HB-98605 will become available during the current quarter, the company says, for $1,700 in quantities of 10 to 24. Discounts on larger orders are also available.

Harris Corp., Melbourne, Fla. 32919.
Phone (305) 724-7800 [Circle 341]

PC/XT-compatible board uses 8088-2 microprocessor

Claiming performance superior to the IBM Corp. Personal Computer/XT, the ACS 1000 PC/XT-compatible single-board computer is based on Intel Corp.'s 8088-2 microprocessor.

The 8.5-by-12-in. board has identical dimensions to its IBM counterpart. In addition to all of the PC/XT's features, the clone boasts an on-board 1-megabyte RAM, a floppy-disk controller for up to four disk drives, a Small Computer Systems Interface hard-disk-drive interface, two serial ports, a parallel



port, real-time and time-of-day/calendar clocks, and a choice of 4.77-MHz or 8-MHz operation.

Built onto a four-layer board with the power and ground planes on the internal layers, the ACS 1000 keeps electrical noise to a minimum without sacrificing integration density. Four memory banks are provided, allowing configurations totaling 256-K bytes, 640-K bytes, or 1 megabyte of on-board capacity. The board has eight systems interrupts and four direct memory access channels. Six 62-pin expansion slots accommodate PC/XT-compatible plug-in boards. It runs on the ACS basic input/output system, an operating system developed to run all programs developed for the PC/XT.

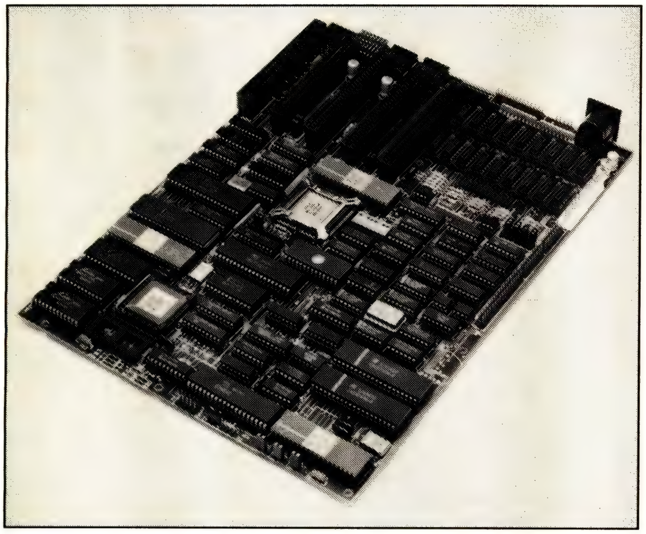
The single-board computer is available now for $595 in single quantities or, for orders of 100 or more, $495.

Advanced Computer Solutions International Inc., 2105 Luna Rd., Carrollton, Texas 75006. Phone (214) 247-5151 [Circle 342]

IBM PC mimic can be configured for robot and process control

Monochrome video and floppy-disk controllers are integrated with an Intel Corp. 8088 microprocessor in the SBM-88 PC Engine, an IBM Corp. Personal Computer mimic that is entirely contained on a single board. The computer is targeted at original-equipment manufacturers who serve industrial automation, engineering and scientific, medical, and office automation markets.

The board has two 28-pin EPROM sockets for use with either the company's ROM-based basic input/output system or any other user-developed code. The ROM BIOS supports MS-DOS, CP/M 86, Concurrent CP/M, and the PC/iRMX real-time operating system.



The manufacturer says the board can be combined with the iRMX-86, an Intel 8087 math coprocessor, and available data-acquisition boards to make a real-time industrial microcomputer for process and robot control, among other applications.

By using four custom CMOS gate arrays to integrate several functions, the SBM-88's designers packed all its features on a single board. The PC Engine supports 256-K bytes of RAM and can be expanded to support up to 640-K bytes. Five IBM PC-compatible I/O expansion slots support a variety of peripherals; standard interfaces for a floppy-disk controller, TTL-compatible video outputs, an IBM PC-compatible keyboard, and Centronics printers are included.

Available now in 64-K, 128-K, and 256-K RAM configurations, the SBM-88 PC Engine sells for under $500.

Mostron Inc., 560 Valley Way, Milpitas, Calif. 95035.
Phone (408) 946-1727 [Circle 343]

Ti-W fuses improve reliability for PLA circuits

Four programmable-logic-array circuits from Texas Instruments Inc. feature maximum switching speeds of 25 ns while operating at a frequency of 30 MHz.

Offering a variety of I/O configurations, the quartet uses titanium-tungsten fuses as the programming elements. The fuses oxidize and cap themselves automatically when the device is programmed, thereby improving reliability, the company says.

The series consists of the PAL20L8A, -20R8A, -20R4A, and -20R6A, and each one includes extra circuitry so that users can load registers asynchronously to either a high or low state. That simplifies testing because the registers can be set to an initial state before executing the test sequence, according to the company.

Currently, the circuits are housed in 24-pin, 300-mil plastic DIPs, but future package options will include 28-pin plastic chip carriers and small-outline packages. Commercial-grade versions are available immediately, and military-grade products are being developed. When packed in the 24-pin plastic DIP and in quantities of 1,000, the circuits cost $8.52 each.

Texas Instruments Inc., Semiconductor Group, Literature Response Center (SC-477), P.O. Box 809006, Dallas, Texas 75360. Phone (800) 232-3200 [Circle 345]

Two multiplier-accumulators offer times as low as 65 ns

Two high-speed 16-by-16 parallel CMOS multiplier-accumulators typically consume less than 250 mW of power—up to 15 times less than existing bipolar or n-MOS counterparts, according to the manufacturer.

The IDT 7210 and 7243 have multiply-accumulate times as low as 65 ns and are compatible with standard TTL circuitry. Both feature selectable accumulation, subtraction, rounding, double-precision addition, and multiplication.

The 7210, which has a preload capacity and a 35-bit result, has individual three-state output ports for the extended product, most significant product, and least significant product. The 7243 differs only in that it offers a full unmultiplexed 19-bit product and has neither a preload capacity nor a least significant product output.

Manufactured with the company's proprietary CEMOS II stepper-aligned dry-etch process, both are available in DIP and leadless chip-carrier packages; military versions are also available. The chips cost $65 each in 100-piece quantities for the 140-ns versions and $140 each for 65-ns parts. Samples can be obtained immediately.

Integrated Device Technology Inc., 3236 Scott Blvd., Santa Clara, Calif. 95054. [Circle 346]

CMOS microprocessor family is priced comparably to n-MOS ICs

A family of low-cost CMOS microprocessors and peripheral ICs operates within the 0°C to +70°C temperature range. The group consists of 18 microprocessors with operating frequen-

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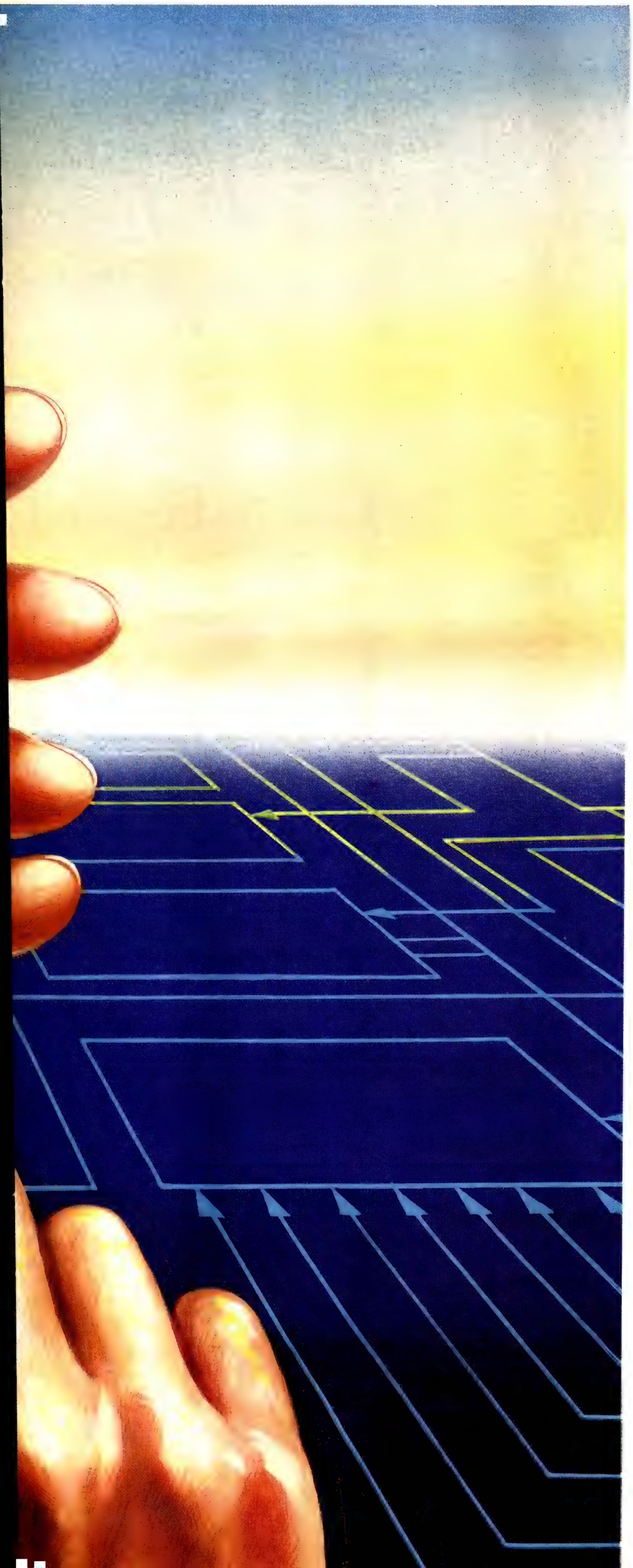

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Circle 71 on reader service card

cies of up to 3 MHz, peripheral-interface adapters, RAM I/O timers, asynchronous-communications ICs, and other supporting devices.

Pricing is competitive with n-MOS devices, starting with the $4 G65SC02P-1, a 1-MHz microprocessor, the company says. Prices for the other 1-MHz devices in 100-unit quantities and in plastic packages range from $3.05 for the G65SC21P-1 peripheral-interface adapter, to $4.10 for the G65SC22P-1 versatile interface adapter, to $4.75 for the G65SC32P-1 CMOS RAM I/O timer.

GTE Microcircuits Corp., Marketing Services, 2000 W. 14th St., Tempe, Ariz. 85281. Phone (602) 921-6505 [Circle 344]

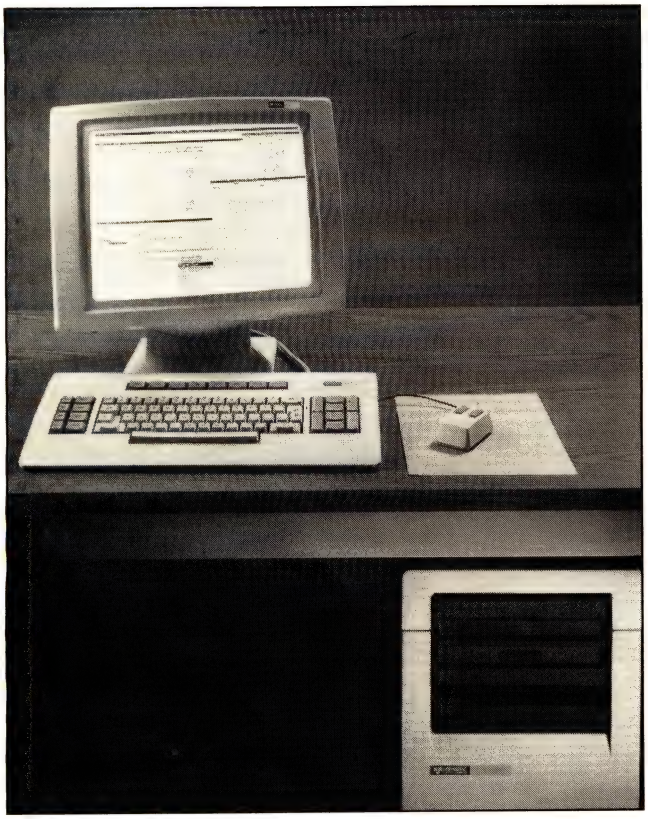
Engineering work station has internal Ethernet interface

High resolution of 800 by 1,024 pixels, multiple windows, and menus are featured on the Versatec Expert work station, an $8,995 unit that includes 768-K bytes of main memory, a 1.2-megabyte double-sided, double-density floppy-disk drive, and a 10-megabyte Winchester disk drive.

The system, which can be upgraded to include a 42-megabyte Winchester disk and 1.5 megabytes of main memory, can run all of the company's engineering-application modules, including schematic design, logic simulation, mechanical drafting, and documentation graphics packages. It can also use Xerox Star office-automation software.

The Expert has a built-in Ethernet interface, but an optional Expert VAX Ethernet (EVE) interface can be purchased to access VAX programs and data, move Expert files to a VAX for processing, and display applications and results in the work station's VAX window. Available for immediate delivery, the work station costs $8,995; the software modules range in price from $6,500 to $14,000, and the EVE interface costs $9,950 for each VAX connection.

Versatec, 2710 Walsh Ave., Santa Clara, Calif. 95051.
Phone (408) 988-2800 [Circle 353]

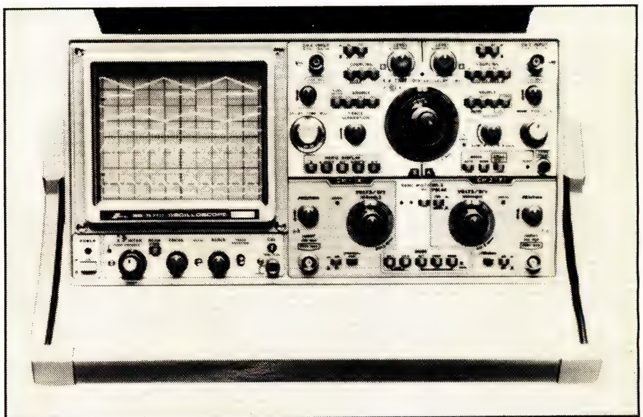


200-MHz oscilloscope delivers eight traces on four inputs

Designed to handle fast digital signals, the SS-5712 dc 200-MHz oscilloscope has four inputs and can display up to eight traces.

In normal operation, the unit outputs two traces, featuring time differences between channels of under 500 ps between channels 1 and 2 and less than 1 ns between channels 2 and 4. The unit reads wider-than-specified frequency response, providing high linearity and an accurate deflection factor and sweep rate, the company says.

With an optional 4-bit combination trigger probe, which can specify 16 trigger conditions and extract the required sequence from a digital circuit, users can pinpoint where on a given trace the oscilloscope should trigger.



The $2,999 instrument comes with a 6-in. quadrupole-lens dome-mesh CRT, plus a jitter-free circuit, a TV-trigger mode, and a three-step bandwidth limiter.

Iwatsu Instruments, 430 Commerce Rd., Carlstadt, N.J. 07072. Phone (201) 935-5220 [Circle 348]

Optical instrument tests LED devices individually

LED products can be individually tested using the SR-300 Optical Diode Tester, an integrated device that tests optical power and electrical parameters using a single-insertion mode.

The unit, which the company says can replace as many as three or four individual instruments, is designed for use in low-volume production, quality assurance, and application and product-engineering testing. The SR-300 measures the major dc and pulsed parameters of LEDs, including forward voltage, reverse leakage current, and total optical power. Current

source up to 500 mA continuous (or 10 A pulsed), dynamic range of 10 pW to 10 mW, and spectral range of 350 to 1,100 nm at ±1% linearity are also tested.

Analog-to-digital conversion is performed in 100 ms, and measurements are updated every 400 ms. A 3.5-digit LED display is the center of the instrument's front panel, which also includes controls to adjust wavelength and other variables. Automatic range selection is also featured on the 13-lb device. The SR-300 costs $3,650 and can be delivered in eight weeks.

Applied Optoelectronic Technology Corp.,
1294 Lawrence Station Rd., Sunnyvale, Calif. 94089.
Phone (408) 734-2516 [Circle 349]

Multimeter's software eases testing in dense circuitry

Overload protection and high-energy fusing are built into a pair of hand-held multimeters, the Fluke 21 and 23, to ensure operator safety.

The meters cost $99 and $145, respectively, and feature LCD displays of both digital readout and analog bar graphs, autoranging, auto-zero, auto-polarity, continuity beeper and diode test, and a rotary dial for simplified function selection. With Touch Hold software, the operator can take readings in dense circuitry (or in zones where high voltage or current presents a hazard) without taking his eyes off the probes. The meter automatically locks the reading into place and then beeps to alert the operator.

The model 21 clears short-circuit faults to over 10,000 A and provides V/Ω protection with a 1,200-V metal oxide varister. The 23 is protected to 100,000 A and has a 430-V metal oxide varister with a spark gap for V/Ω protection. The Fluke 21 provides 0.5% basic dc accuracy and the Fluke 23, 0.3%.

John Fluke Manufacturing Co., P.O. Box C9090, Everett, Wash. 98206.
Phone (800) 426-0361 [Circle 347]

1-Mb ROM can access information in 150 ns

Full-speed operation of microprocessors without wait states is possible with the VT231024 1-Mb ROM, whose 150-ns access time is the fastest yet for a device of its size, the company says.

The VT231024 is built in a sub-2-µm high-performance MOS process and consumes 225 mW in the active state (50 mW on standby). Packaged in a 28-pin plastic DIP, delivery of production volumes is promised five weeks after the customer's code verification. Samples are available immediately.

VLSI Technology Inc., 1109 McKay Dr., San Jose, Calif. 95131.
Phone (408) 942-1810 [Circle 351]

Integrated RAMs are suited for battery-powered operation

Combining the cost advantages of dynamic RAMs and the simplicity of use of static RAMs, two CMOS integrated RAMs are a low-cost alternative to byte-wide static RAMs in general purpose microsystems.

Using the company's proprietary CHMOS process, the two memories, dubbed 51C86 and 51C87, have access times as fast as 120 ns and operating power half that of static RAMs, the company says. The devices dissipate as little as 50 µA of current on standby.

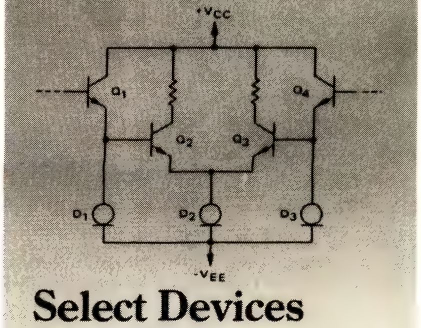
Designed for use in low-density applications where less than 64-K bytes of RAM is needed and where component speed and size are important, the two are suitable for battery-powered operations. Integrated RAMs have all necessary memory-refresh-control circuits on the chip, so their functions are transparent to the user. The 51C86 is self-refreshing; the user controls the 51C87's refresh. Both are available now for $9.25 in quantities of 1,000.

Intel Corp., Literature Dept. W197, 3065 Bowers Ave., Santa Clara, Calif. 95051.
[Circle 352]

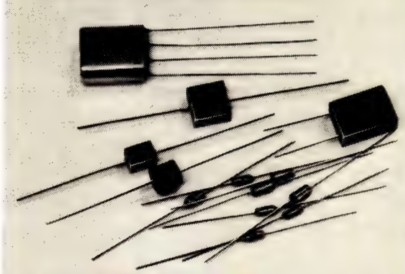
All 50 positions on connector are filtered

Manufacturers of PBX equipment are offered the SIG filtered connector, a single-assembly connector that is incorporated into a 50-position receptacle. All 50 positions are filtered using proprietary

Selected Applications



Select Devices



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- High capacitance, wide area varactors to 1320 pf, with Q to 200.
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Circle 73 on reader service card

ceramic-chip capacitors mounted in a flexible, metallized-plastic chip carrier. This flexible package, the manufacturer says, allows the interconnection between contacts and capacitors to float, decreasing the possibility of damage to the capacitors.

The SIG filtered connector uses antiresonant, high-voltage capacitors and a proprietary compliant carrier system (for which a patent is pending). This eliminates a common cause of failure of capacitors currently used in bypass filter applications. The connectors meet the 1,000-V-ac, 60-Hz, 100-mA minimum continuous source requirement of the Federal Communications Commission Part 68 specification. In addition, it exceeds the FCC Part 15 and Part 68 requirements for radiated and conducted interference and high voltage.

The assembly can be used in both pc-board-mounted and panel-mounted ribbon-cable configurations, giving telephone-equipment designers freedom in connector placement. Unit prices vary depending on customization, with the average cost ranging between $11 and $15, when the connectors are ordered in quantity. Production orders are being shipped this month.

Future Plus Inc., 2412 Amsler St., Torrance, Calif. 90505.
Phone (213) 534-3990 [Circle 368]

Capacitor burn-in system tests up to 14,400 devices at once

Simultaneous testing of as many as 14,400 capacitors can be performed in accordance with MIL-C 39014 and 39123 specifications with the 1027D-39014-20 capacitor burn-in system. A mother-tray/daughter-card system, in which 20 trays each accept up to nine 80-device daughter cards, increases the device count and adds flexibility to the test process; each tray can be supplied with a different test voltage.

Daughter cards are available for capacitors packaged in DIPs and single in-line packages. Load-monitor cards place capacitors in parallel and monitor the capacitor bias voltage. One load monitor card is needed for each mother tray. If the capacitor bias voltage falls below 95% of the supply voltage, the monitor system disconnects the capacitors from the supply and activates a warning light.

Delivery takes up to 12 weeks. It is priced according to users' specific requirements.

Micro Instrument Co., 2250 Micro Place, Escondido, Calif. 92025
Phone (619) 746-2010 [Circle 354]

Vapor soldering system links with RS-232-C-based computers

Operable either locally or remotely, the Vapor Phase Reflow System controls and monitors single vapor soldering of surface-mount devices to any common pc-board substrate.

The RS-232-C-compatible system integrates the soldering facility with a communications ability that allows the system to communicate with host computers and related manufacturing equipment. The menu-driven system provides computer loop outputs, reporting on management data, malfunctions, and maintenance requirements.

The Vapor Phase Reflow system regulates five temperature settings and can be used on a wide range of SMDs with either single- or double-sided attachments.

Prices start at $67,000 and depend on options. Descriptive literature is available now.

Dynapert-HTC, Marketing Department, Pond Lane, Concord, Mass. 01742. Phone (617) 369-1110 [Circle 355]

High-speed electronic pulses protect work from excess heat

Ultraviolet adhesives and coatings can be cured at a rate of up to 30 cures/min with the RC-250A Precision UV Adhesive Curing System.

The unit, which has a ⅜-in.-diameter quartz light source, transmits minimal heat to the work area so as not to harm heat-sensitive parts. The RC-250 uses high-speed electronic pulses of 5 to 10 ms that instantly turn the unit on and off to provide deep penetration of UV adhesives without the risk of burn damage. The curing system's hand-held probe has a flexible cord for easy maneuverability.

Options available include a filtered lamp for 250-nm cutoff that eliminates the minimal amounts of ozone produced by the lamp in normal operation; a facility for varying the cure time from 0.1 to 4.0 s with a front-panel control; a power enhancement that effectively doubles the average output power; an on/off foot switch; and a ¾-by-1-in. light-source baffle for applications where users might attach lenses to the probe. Available immediately, the system sells for $1,700.

Xenon Corp., 66 Industrial Way, Wilmington, Mass. 01887.
Phone (617) 658-8940 [Circle 356]

Software analyzes semiconductor costs

Semiconductor buyers and manufacturers are offered a software-analysis aid called Passport, which provides information on in-house or vendor semiconductor costs. Passport is a natural-language knowledge-based system that runs on the IBM Corp. Personal Computer and compatibles with 64-K bytes of memory under PC-DOS 2.1. Inputs such as wafer diameter, resolution, clean-room conditions, packaging costs, and screening levels create an interactive model of a manufacturing facility; adjusting any of these inputs will automatically modify the whole program to take the adjustment into account. Then, actual costs and suggested fair-market prices are provided according to quantities and overhead inputs.

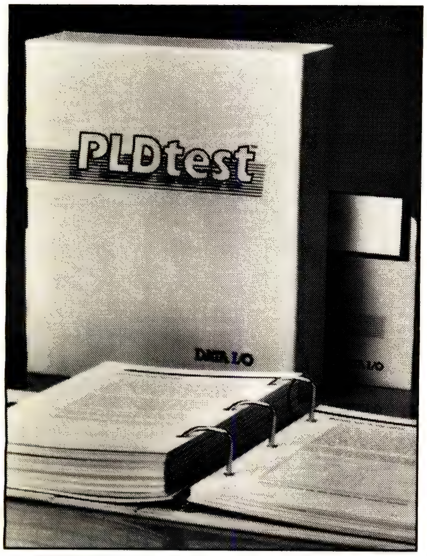
Priced at $145, Passport is available for immediate delivery. For manufacturers and vendors with specialized needs, the source code can be customized for an additional charge.

Fountain Hills Software Inc., 6900 E. Camelback Rd., Suite 1000, Scottsdale, Ariz. 85251. Phone (602) 945-0261 [Circle 361]

Software tests devices and nails down faults

Testing problems associated with programmable logic devices are addressed by PLDtest software, which determines the testability of conceptual designs and performs fault grading for finished designs. A PLDtest cycle contains two steps: first, the engineer specifies the device and the desired input- and output-file format (for example, Joint Electron Device Engineering Council format); then, PLDtest automatically processes the input file, creates test patterns, minimizes test vectors, performs path sensitization, and creates a test file.

This software also lets engineers generate any test vectors required to fully test a programmed logic device, to the point of determining whether a fault can be detected at the output pins—the ultimate requirement for testability. PLDtest performs fault grading by simulating the operation of the design, then after simulation tracing a path backward from each output pin to determine which faults are detectable from that pin. Final output can take the form of Jedec files, the firm's Abel files, or a generic format that can be translated for other testers.



Written in C language, PLDtest sells for $995 in the MS-DOS version, while the VMS and Unix versions sell for $2,495. Orders will be filled in eight weeks.

Data I/O Corp., 10525 Willows Rd. N.E.,
P.O. Box 97046, Redmond, Wash. 98073.
Phone (206) 881-6444 [Circle 362]

Real-time software comes mated to silicon

The iAPX series of microprocessors has been enriched by the addition of a real-time operating system called Portable Real Time Executive—Portx. Silicon-imbedded software, Portx features an extremely low interrupt latency, a figure critical to such real-time applications as process control, instrumentation, data acquisition, and robotics.

Event flags and semaphores can be intermixed in process synchronization, while, for interprocess communication, Portx provides both message packets and streams (pipes). Scheduling routines include priority scheduling and time slicing. Requiring less than 6-K bytes of memory, Portx can be delivered in PROM masters (2732 or 2764) or on disk. It is available from stock, and a development license for five copies costs $5,100.

The Destek Group, 830 E. Evelyn Ave., Sunnyvale, Calif. 94086.
Phone (408) 737-7211 [Circle 360]

Pattern generator's images exhibit low defect densities

Boasting five times the throughput of its predecessor, the 4600L Pattern Generator relies on a xenon chloride excimer laser to produce over 100,000 flashes/h on chromium. With

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Karlheinz Bretthauer, Klaus Jansen, Vacuumschmelze

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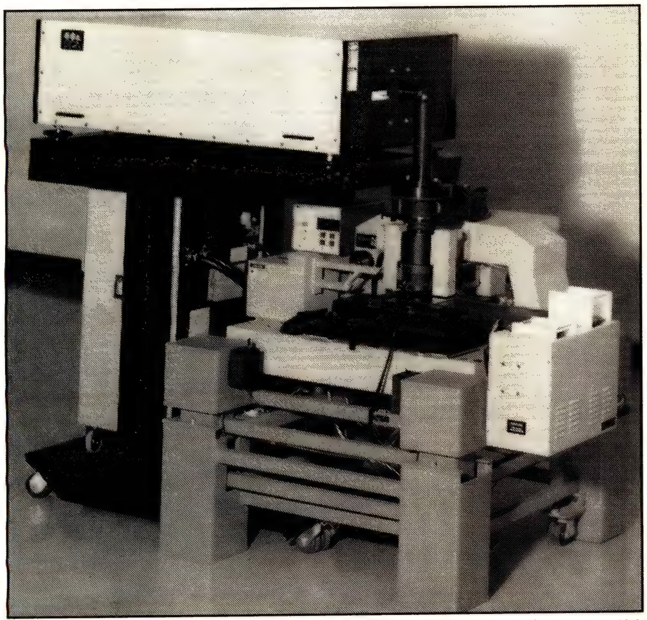
Circle 75 on reader service card →



standard optical photoresists, it produces images of 2 to 1,500 μm with low defect densities, the company says.

The system consists of a Zeiss 20× lens corrected to the laser wavelength, a Digital Equipment Corp. PDP-11/73 computer, and a robotic plate handler that can connect with other equipment and processes. The robot can handle plates up to 8 by 8 by 0.25 in. thick in 8-in.-square envelopes.

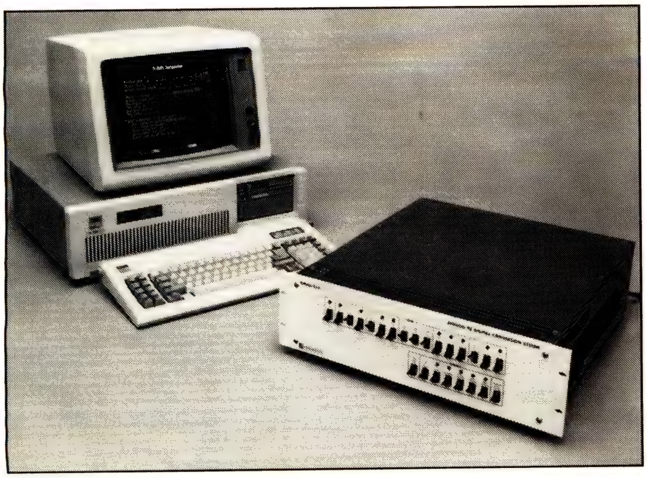
The base price for the 4600L is $700,000, and an upgrade kit for the company's earlier model, the 3600F, is also available.

GCA Corp., Sales Department, 209 Burlington Rd., Bedford, Mass. 01730. Phone (617) 275-5400 [Circle 359]

Subsystem permits 1-MHz data conversion on IBM PCs

An interface subsystem, the model MPC, puts this manufacturer's 1-MHz analog-to-digital data-conversion GM and EM series systems within the grasp of IBM Corp. Personal Computer users. The MPC also provides hardware and software interfacing to IBM PC/XT, PC AT, and compatibles. Requiring only eight I/O addresses, the interface subsystem transfers data files at an average rate of 160-K bytes/s, with 300-K bytes/s possible.

The GM and EM data-conversion systems feature real-time data acquisition, continuous data throughput at 88.5-kHz direct memory access until the computer's memory is filled, and burst-type high-speed throughput until the first-in, first-out shift register is full at 24,000 readings. As an option, N number of channels can be sampled at burst rates up to 1 MHz/(N+1) channels for a period of about 24 ms.



MPC interface software uses the IEEE-488 protocol and can interface other devices connected to its bus. The software that controls the hardware interface is designed as a loadable device handler rather than a driver—that is, it is installed as part of the operating system. The operating system, PC-DOS 2.0, then manages the MPC as one of its system resources.

Low-level primitive calls let the interface accept custom original-equipment-manufacturer devices or configurations, and high-level calls may be used to set up the GM or EM subsystems.

Interpreted Basic is the standard high-level language interface on the MPC, but Fortran, Supersoft Fortran, Compiled Basic, Pascal, assembly language, and C language are available as options. The software driver may be integrated with existing or future application programs developed by the user.

Price depends on the number and type of channels, conversion rate, and resolution. A typical 16-channel, 500-kHz 13-bit system costs $10,910, and delivery of most systems will be made in 30 days.

Preston Scientific, 805 E. Cerritos Ave., Anaheim, Calif. 92805. Phone (714) 776-6400 [Circle 367]

Data-acquisition system links with any computer

A 12-bit integrating analog-to-digital converter (–4 to +4 V with 1-mV resolution) and 8 bits each of digital I/O are present in this programmable data-acquisition and -control system. Based on the 6802 microprocessor, the system contains its own power supply and a 2,000-point data buffer. A data-termination-equipment and a data-communication-equipment RS-232-C port provide ASCII communication at rates from 150 to 19,200 baud, and the system interfaces to any computer with an RS-232-C port.

Software includes a real-time clock, pulse counting to 4,500 pulses/min, event timing to 23 μs, 24 addressable I/O channels, and triggered and timed data-logging modes. Additional software may be downloaded into RAM.

The complete system is priced at $690, and discounts are offered to original-equipment manufacturers. Custom ROMs are available. The standard system is currently being shipped from stock.

Starbuck Data Co., 225 Crescent St., Waltham, Mass. 02154. Phone (617) 899-8629 [Circle 366]

Multiuser system offers wide range of storage choices

Flexible data storage in a variety of configurations—up to 50 megabytes of hard-disk storage for four terminals, or up to 20 megabytes of hard disk and a 10-megabyte streaming-tape backup for a single-user work station—marks the Dimension 68000 system.

The four-user configuration runs under Uniplus (a licensed implementation of Unix System V with enhancements) and features dual 68000 microprocessors in a proprietary architecture. It includes 1 megabyte of RAM, addresses up to 16 megabytes, and has two 5¼-in. 400-K-byte drives. Software includes the Uniplus operating system, a 68000 assembler, and C language and Snobol; the graphics set is under software control.

Four serial ports are standard on the system's four-user configuration. Other standard equipment includes six expansion slots, a disk controller for up to eight drives, an RS-232-C full-duplex serial port, a CRT display controller and composite

video output (CRT not included), and a graphics port.

As a single-user work station, the Dimension 68000 runs under the CP/M-68K operating system, with a UniBasic interpreter, a 68000 assembler, and C language and utilities.

The four-user Unix system costs \$9,995 without terminals and with a 20-megabyte hard disk or \$14,995 for the same 20 megabytes of hard disk plus terminals. For the single-user CP/M-68K-based system, 512-K bytes of RAM with two 800-K-byte 5¼-in. drives goes for \$4,795; other configurations cost from \$3,995 to \$7,995 (which includes the 10-megabyte streaming tape drive).

Micro Craft Corp., 4747 Irving Blvd., Suite 214, Dallas, Texas 75247.
Phone (214) 630-2562 [Circle 365]

Tantalum chip capacitors eschew conformal coating

Tantalum chip capacitors with precision-molded surfaces for high-speed vacuum pickup offer an improvement over conformal-coated chips in pick-and-place assembly, the manufacturer says, because conformal coating leaves a rougher surface.

In addition, completely flat leads allow these chips to sit without "spring" on the substrate. At the same time, the leads move with temperature changes during soldering without affecting the anode. The layers of the chip are built up by a wet process in which the ceramic is deposited as a slurry, a technique that prevents the formation of voids and reduces the likelihood of delamination. On the customer's request, the manufacturer will subject the chips to the (nondestructive) methanol test for delamination.

Fast turnaround of orders—9 or 10 weeks' delivery time—gives the manufacturer of the end product an edge in getting to market with products using these chips. This line of tantalum chip

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Features, technology, and price improvements in a category of equipment fast becoming standard for design engineers. Demand for shortened design cycle times, increased productivity, enhanced design quality, and the incorporation of multiple job functions is pushing for added market growth. Future increases in horsepower, additional system memory, and graphics will boost demand further in this \$350 million market. This article will directly benefit systems designers, managers, and integrators.

**Issue Date:
June 24, 1985**

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**McGraw-Hill ElectronicsWeek
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capacitors has received IECQ approval, a standard widely adhered to in Europe. Being able to offer compliance with this standard in the finished product is an advantage in overseas marketing, the manufacturer points out.

Available in seven case sizes, this capacitor series offers a voltage range of 6.3 to 35 V and capacitance from 0.1 to 100 μF. The chips are packaged in either tape-and-reel or waffle packaging and will withstand solder temperatures to 250°C. Prices will depend on customer requirements and will be quoted on request. Samples are available now.

Stantel Components Inc., 636 Remington Rd., Schaumburg, Ill. 60195. Phone (312) 490-7150 [Circle 371]

Capacitors are coated to resist solder heat

Conformally coated with thermosetting, unfilled epoxy urethane to withstand wave-soldering temperatures, the series 703C1 capacitors consist of low-induction wound cells of tin-lead foil with a polystyrene capacitor lead film. The axial leads are tinned copper wire (22 AWG). Capacitance of these components ranges from 56 pF to 0.018 μF, and voltages available are from 63 to 630 V. They feature low self-inductance and series resistance, the manufacturer says.

Offered in tape-and-reel packaging for automatic insertion, the capacitors are suitable for vertical or horizontal mounting. Typical pricing for a 1,000-pF, 250-V unit at ±1% tolerance is 22¢ each in 5,000-piece quantities. Delivery is from stock, taking 12 weeks after receipt of order.

Mepco/Electra Inc., Columbia Rd., Morristown, N.J. 07960. Phone (201) 539-2000 [Circle 372]

Digital transmitter-receiver pair form mainframe link

Mainframe-to-mainframe links, local-area networks, and process control for factory automation are some applications for these fiber-optic digital transmitter-receiver models. The HLP/HPL118 digital links accommodate both synchronous and asynchronous data transmission at rates up to 100 Mb/s. Pulse-width distortion is ±1.5 ns or less, and dc coupling eliminates rate-dependent effects, the manufacturer says.

Automatic threshold control ensures full operation independent of the fiber length. Operating with either differential ECL or TTL signals, the HLP/HPL118 fiber-optic links can be incorporated into a wide range of designs.

Available as a 20-pin DIP and with Amphenol 906 series connectors, the transmitter-receiver links are priced at $495 a pair. Delivery will be made in eight weeks following receipt of order.

LeCroy Research Systems Corp., 700 S. Main St., Spring Valley, N.Y. 10977. Phone (914) 425-2000 [Circle 369]

Butterfly laser package runs at 565 megabytes/s

Designed to operate at 565 megabytes/s and higher, this 14-pin butterfly laser package contains a 1,300- or 1,500-nm channeled-substrate narrow-stripe laser diode coupled to a single-mode fiber. The device is available with either a germanium back-facet monitor or a low-electrode-dark-current HgCdTe detector. The laser output is optimized for high-speed modulation, with optical rise times of less than 0.2 ns.

A thermoelectric cooler and thermistor allow for temperature stabilization and control. The package is temperature-compensated to minimize inner mechanical stresses on the fiber pigtail.

Evaluation units will be available in the third quarter of 1985, with production orders scheduled for fourth-quarter delivery. The product is also available with connectors and custom fiber. In quantities of 1 to 10, the single-mode 1,300-nm model is priced at $4,950 per unit; the single-mode 1,500-nm model is $9,000.

General Optronics Corp., Optical Communications Products Division, 2 Olsen Ave., Edison, N.J. 08820. Phone (201) 549-9000 [Circle 370]

400-W power supply produces high current

A 400-W switching power supply designed for stand-alone computers and communication systems with large logic-current loads, the model SX400 features an open-frame configuration, protection and automatic recovery from short circuits, and input surge-current protection with soft start. The unit is also brownout-rated. The SX400 with +5-V output is rated at 50 A and meets specifications of the Underwriters Laboratories, VDE, International Electrotechnical Commission, and Canadian Standards Association. Certification by Technische Uberwachungs-Verein is pending.

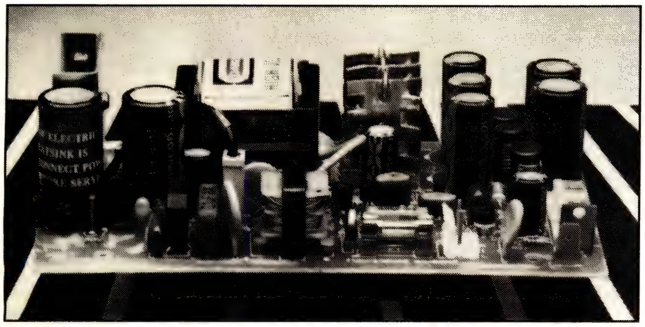
In quantities of 100 to 249 units, the SX400 switching power supply is priced at $485 each. Samples are available now, and production quantities are available in 60 to 90 days after receipt of order.

Summit Electronics Inc., 855 E. Collins Blvd., Richardson, Texas 75081. Phone (800) 645-2074, in Texas (214) 231-1456 [Circle 373]

40-W open-frame supply meaures 6.3 by 3.9 in.

Disk-based microcomputer systems are targeted by the EL series of power supplies. The latest in this series of 40-W open-frame, multiple-output switchers, the model EL30401-1 offers output characteristics of +5 V at 3.5 A, +12 V at 2.0 A, and –12 V at 0.6 A. Short-circuit and overvoltage protection are provided. Efficiency is 70% (typical), and the unit meets VDE 0871 class B conditions for a 115-V ac power supply.

Available with Molex or terminal connectors, the EL30401-1 40-W power supply is 6.3 in. long by 3.9 in. wide by 1.9 in. high. Delivery will be made in up to four weeks, and in



original-equipment-manufacturer quantities, the unit is typically priced at $36.

Elpac Power Systems, 3131 S. Standard Ave., Santa Ana, Calif. 92705.
Phone (800) 438-0600, in California (714) 979-4440 [Circle 374]

System tests transmission paths remotely with only one operator

Operators need less than an hour to test remote analog transmission paths with a system called Jason. Transmission lines can be tested from a central site without installing expensive diagnostic modems throughout the network.

The software-based Jason concentrates control of an entire network's modem-to-modem testing at a single terminal. There, through a standard screen interface, a user can execute menu-driven diagnostics and activate such remote test equipment as data- and voice-frequency analyzers.

Six standard quick-scan tests can be executed, including bridged and terminated measurement testing for noise, level, and frequency; single- or multipoint circuit loopback tests; seven-point frequency-response test; and bit-error rate test.

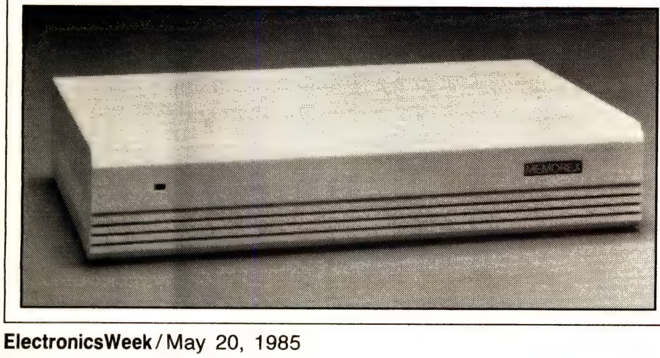
Jason reduces testing time because it is no longer necessary to coordinate staff and test equipment at both ends of a line. With one call, operators can test all elements of a transmission path, including lines, modems, and terminals. Including hardware—a Digital Equipment Corp. PDP-11/73—and a software license, Jason is priced starting at $118,400. Delivery takes 90 days.

Comm+Systems Inc., 327 Eastlake Ave. E., Seattle, Wash. 98109. Phone (206) 292-4400 [Circle 377]

Cluster controller suits small business with limited needs

For customers who don't need the capacity of 16 ports, the 8-port 2174-8 remote cluster controller operates within IBM Corp.'s Systems Network Architecture/Synchronous Data Link Control communications protocol. Through a modem, the 2174-8 controls remote communications with multiple hosts, including the IBM 370, 303X, 308X, and 43XX families of processors.

Compatible with the IBM 3274-51C cluster controller, the 2174-8 supports communication-line speeds of up to 9 kb/s over half- or full-duplex communications facilities. As many as eight Memorex Corp. or IBM 3270-compatible category A peripherals can each be connected by coaxial cable to the remote cluster controller.



The 2174-8 supports programming languages, graphics for the 2078 and 2079 display stations, extended colors for the 2079 color display station, and light pens. Available immediately, the controller is priced at $5,595 each.

Memorex Corp., San Tomas at Central Expressway, Santa Clara, Calif. 95052. Phone (408) 987-3593 [Circle 379]

Wireless modem hooks up to 255 computers or peripherals

Up to 255 computers and peripherals can be networked with the Esteem wireless modem. Within the same building, the Esteem model 84 can connect computers equipped with a standard RS-232-C interface without the constricting binds of cable.

Regardless of the serial port's transmission speed (from 50 to 19,000 baud), the Z80 microprocessor in each Esteem can facilitate communication between points on the network through its 1-W transmitter/receiver operating on narrowband FM VHF. Users choose one of 24 channels to operate on as well as the unique address for each node on the network.

Prior to transmission, data is encoded in the Higher Data Level Link format using packet-radio transmission technology. The data received is screened for errors; if any are detected, it is retransmitted automatically. Esteem networks do not require special software or internal computer cards. The modems are connected to the desired equipment with an RS-232-C serial cable.

Available now, the wireless modem is priced at $995.95 each.

Electronic Systems Technology, 1031 N. Kellogg St., Kennewick, Wash. 99336. Phone (509) 735-9092 [Circle 380]

Unit controls brushless motors without the aid of a tachometer

For use in adjustable-speed applications, the microprocessor-based Pac Sci 081 brushless motor control drives up to 7½-hp permanent magnet brushless motors with Hall sensor shaft-position feedback. The control uses a speed-compensation loop that provides very tight speed regulation without the need for a tachometer.

The unit maintains ±5 rpm over a wide speed range from 100 to 10,000 rpm. On the operator panel are a potentiometer for adjusting speed and lighted switches for selecting start, stop, forward, reverse, and jog modes.

The motor control is suitable for applications such as metering pumps, dry solid feeders, and specialty-machine drives. The Pac Sci 081 sells for $1,900 each and prototypes are available now.

Pacific Scientific Co., Motor & Control Division, 4301 Kishwaukee St., P.O. 106, Rockford, Ill. 61105. Phone (815) 966-3600 [Circle 382]

Micron-graded, film-backed polishing products for finishing components and circuit boards, lapping magnetic-tape and disk-drive heads, and other finishing operations are available in 12- and 9-μm grits. The manufacturer will vary the abrasive density and hardness of the bond to customer specifications. The polishing products, which can be used in wet or dry applications, are said to replace wet-grain slurry processes.

Norton Co., Abrasives Marketing Group, 1 New Bond St., Worcester, Mass. 01606. Phone (800) 446-1119 or (617) 853-1000 [Circle reader service number 421]

Low-resistance wire-mesh screen that is laminated between two layers of glass or acrylic creates a window that shields against electromagnetic interference. The sandwich is mounted with an emi gasket seal that provides uniform mesh-to-enclosure continuity. Teckshield-F windows have proven effective in Tempest-qualified visual-display units and are recommended for teleprinters and digital, graphic, and other flat displays. The maximum window size is 355 mm by 457 mm, with a standard thickness of 5.2 mm.

Tecknit, 129 Dermody St., Cranford, N.J. 07016. Phone (201) 272-5500 [Circle 423]

Subminiature cable ties with a profile head 0.115 in. high, for use on small bundles and in tight wiring spaces, are easy to handle, says the manufacturer. The PLT.7M tie has finger grips that are well-defined and requires little threading force. The tip-holding feature retains the tip in the head, so that the operator can let go of the tie after starting the tip but before threading the fine-pitched teeth. Minimum loop tensile strength is 18 lb, and maximum bundle diameter is 0.68 in.

Panduit Corp., Electrical Group, 17301 Ridgeland Ave., Tinley Park, Ill. 60477. Phone (312) 532-1800 [Circle 424]

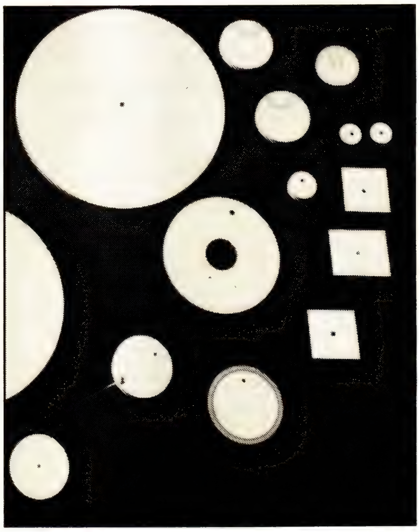
Solid copper common grounds, replacing large bus bars and plates, reference connection points for a wide range of computer and other electronic hardware. Eight prethreaded and numbered I/O holes distribute power among as many as 16 separate subsystems. The common grounds are available in 1- to 2-in. or custom diameters, and they connect by means of crimp-on terminals.

Spec Laboratories, 241 Crescent St., Waltham, Mass. 02154. Phone (617) 891-5200 [Circle 427]

Threaded self-clinching standoffs, used to attach the frame of a computer keyboard to the pc-board assembly, maintain the spacing between layers of assembly by permitting stacking. When pressed into the 1/16-in.-thick metal frame, the hexagonal head of each standoff is flush with the sheet surface for an attractive panel finish. The manufacturer stresses the reliability of these standoffs in full-travel applications.

Penn Engineering & Manufacturing Corp., P.O. Box 1000, Danboro, Pa. 18916. Phone (215) 766-8853 [Circle 425]

In environments where the ambient temperature ranges up to 450°C, lead metaniobate crystals are recommended for such applications as force gauges and accelerometers. Wide variations in temperature have little effect on its dielectric or piezoelectric constants, the manufacturer says. Offered in various shapes including disks, rings, and plates, lead metaniobate's low mechanical Q recommends it for sensors in wide-bandwidth applications.



Nittany Piezo Ceramics Inc., Pine and Mill Streets, Bellefonte, Pa. 16823. Phone (814) 355-1594 [Circle 422]

Micro hand tools for printed-circuit artwork and repair, strain-gauge work, magnetic-head work, and other microelectronics tasks are available in a set of eight: straight, 30°, and 90° probes; and a chisel, knife, graver, diamond scribe, and measuring scale. The set comes boxed in a wooden case with hinged lid.

Hunter Products Inc., 792 Partridge Dr., Bridgewater, N.J. 08807. Phone (201) 526-8440 [Circle 431]

Developed for harsh temperature environments ranging from the cryogenic to 550°F, Envex 1228 polyimide has found application in aircraft environmental control systems. Under high load conditions, the material has a compressive strength of 13,100 lb/in.^{2}, a 0.12 coefficient of friction, and a pressure-velocity capability that exceeds 100,000 lb/in.^{2}-ft/min. Envex 1228 is available in rod and tube form, 10 in. long with diameters from ¼ in. to 2 in.

Rogers Corp., 1 Technology Dr., Rogers, Conn. 06263. Phone (203) 774-9605 [Circle 428]

Solder pastes developed for screen-printing, the S-series incorporate atomized metal powder, appropriate flux, and special paste binders. The pastes break away cleanly from the screen and workpiece, leaving no dripping tails that might spoil the next printed image, the firm says. A wide range of heat sources including convection ovens and infrared systems may be used to melt the solder alloys. The flux residue after heating is nonconductive and noncorrosive.

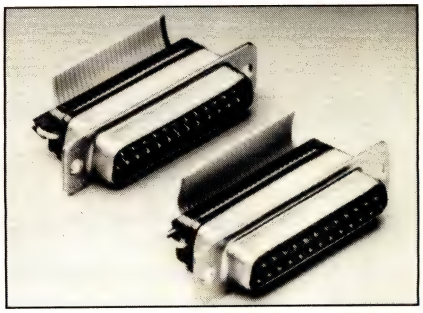
Fusion Inc., 4658 E. 355th St., Willoughby, Ohio 44094. Phone (216) 946-3300 [Circle 429]

A copolymer that provides consistent material clarity without the use of polyvinyl chloride, Super-Clear is recommended for custom packages, such as tote-box lids and DIP tubes, that require electrostatic dissipation. Triboelectric (friction) generation of Super-Clear is low, comparable to that of aluminum, the manufacturer says. Available in clear or in blue tint for color-coding purposes, Super-Clear is manufactured as an injection-molding-grade compound or in vacuum-formable sheet from stock.

Olympic Plastics Co., 5800 W. Jefferson Blvd., Los Angeles, Calif. 90016. Phone (800) 223-8607; in California, (213) 223-8607 [Circle 430]

Metal shells have been added to the 770 series D-type connectors (pictured) and 780 series ribbon-type connectors, for protection against electromagnetic and radio-frequency interference (emi and rfi). The 770 series offers mass termination with 0.05-in.-pitch flat cable and 25-pin insertion force of 10 kg (maximum). The 770 and the 780 series operate in the temperature range of –55°C to +105°C, and have voltage ratings of 250 V ac.

Fujitsu America Inc., Component Division, 918 Sherwood Dr., Lake Bluff, Ill. 60044. Phone (312) 295-2610 [Circle 426]



We Were One Of The First To Recognize The Potential Of Gallium Arsenide. Who Else Could Better Recognize Your Potential?

We're Harris Microwave Semiconductor, a division of Harris Corporation, the $2 billion Fortune 200 company. We've been on the leading edge of gallium arsenide and microwave technology from the very beginning. Today, we're still ahead of our competitors in the microwave industry with our line of high demand microwave amplifier component products. And, last May we created quite a stir by introducing the world's first commercially available Digital GaAs IC. We've also recently been one of a select group of companies to be honored with the Product of the Year award by Electronic Product magazine.

We Still Have A Small Company Spirit.

As the industry leader, we can offer talented engineers more professional challenges in our state-of-the-art environment. But, we kept our entrepreneurial spirit. So, at Harris you'll get the kind of visibility you would expect from a smaller company.

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You should be an expert in high frequency (microwave) circuit design and have a solid background in GaAs FET circuit matching in MICs and MMICs.

LSI Program Engineers

You must have a BSEE or the equivalent, with experience as a project leader, at least 2 years in digital IC design and device modeling, plus a working knowledge of fab operations.

IC Applications Engineers

A BSEE or equivalent and at least 2 years experience in the use, design, and/or testing of high speed digital ICs or microwave systems are required.

MIC Amplifier Product Engineers

You'll need a BSEE or the equivalent, a minimum of 3–5 years experience in amplifier product engineering or design, along with strong interpersonal and troubleshooting skills.

Manager, Product Sales

Strong communications skills, a background in sales forecasting and 1–5 years of sales experience as well as the ability to motivate your sales staff is required. Experience with GaAs based products is a plus.

Amplifier Design Engineers

You should have a BSEE, 1–3 years of experience (or the equivalent) in thin film GaAs FET amplifier design or MMIC design and a working knowledge of GaAs device physics. Experience with military amplifier programs is a plus.

Microwave Test Supervisor (Swing Shift)

You must have 3–5 years of direct experience in MIC GaAs FET amplifiers with at least 1 year of supervisory experience. You'll also need excellent communication skills. A 2 year degree in a technical or business field is preferred.

New breakthroughs, new challenges, and new opportunities for growth are what Harris Microwave Semiconductor is all about. Interested candidates should send resumes to: Supervisor Human Resources, Harris Microwave Semiconductor, 1530 McCarthy Blvd., Milpitas, CA 95035. We are an equal opportunity employer M/F/H/V.

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UPCOMING EDITORIAL SCHEDULED FOR ELECTRONICS WEEK JUNE '85 ISSUES

Issue Date	Editorial Emphasis
June 3	32-Bit Microprocessors
June 10	Special Report: Relays
June 17	Automotive Electronics
June 24	The Next Generation of Engineering Workstations

JOBS JUNE JOBS JUNE JOBS JUNE JOBS JUNE JOBS

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Consultant / Junior Engagement Manager to direct & coordinate activities of members of consulting teams in the preparation of strategic management studies for clients involved in the electronics & technology industries; to manage consultations with clients to define problem, conduct studies to obtain data & analyze data utilizing principles of physics & business management; prepare & present written report to client setting forth recommendations for improvement of corporate operations. MBA and BA in Applied Physics required as well as one year, six months in the Job Offered or one year, six months as an Associate Consultant involving technology management. Must have had at least one course or one research project utilizing FORTRAN IV computer language. 35 hrs. per wk. M/F. 9:00 a.m. to 5:00 p.m. $58,000 per annum. Send resumes to: Illinois Job Service, 910 S. Michigan Avenue, Room 333, Chicago, IL 60605; Attn: Joan Haight; Reference #: 4511-H. An Employer Paid Ad.

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LETTERS

No figures yet

To the editor: Your article, "RISC technology moves off campus" [*ElectronicsWeek*, April 29, 1985, p. 36], was in most ways a discerning piece on a much misunderstood subject. However, it contained a misunderstanding of one statement I made, and at another point could be taken as attributing to me some statements by others.

The first products to be built using VLSI will be designed in Hewlett-Packard's advanced 1-µm process, NMOS-3, which has been in production for over two years now. Some early implementations may use more conventional technologies, such as TTL. Your article does say, "The chip *reportedly* [italics mine] runs at 8 to 10 mips," and then goes on to say, "HP also has a 5- to 7-mips TTL processor and a 15-mips ECL machine in the wings." Although it is clear that you do not attribute that to me, these statements occur between two direct quotes from me, so won't most readers take them to be mine? They aren't.

We don't yet know what will be the performance of these future products, and I'd like to leave our competitors to speculate on what we may have in the wings.

George E. Bodway, General Manager
Information Technology Group
Hewlett-Packard Co.
Cupertino, Calif.

Unix fan

To the editor: Your piece updating the fortunes and misfortunes of the Unix operating system [*ElectronicsWeek*, March 4, 1985, p. 47] was excellent. As an overview, it was balanced, accurate and complete—with one small exception.

Along with Motorola, Intel, and National Semiconductor, Zilog Inc. too has signed an agreement with AT&T Co. to develop System V for our microprocessors. We believe that our participation in the System V porting process will further assist the cause of standardization and enhanced applications so crucial to the success of the operating system.

Robert F. Andrews
Director of Marketing Support
Components Division
Zilog Inc.
Campbell, Calif.

Correction

We goofed. On the May 6, 1985 cover, the word "tomorrow" was misspelled. Apologies to those we confused, a weak smile to those who wanted to know who Tom Morow is, and a "Gotcha!" to those who never noticed.

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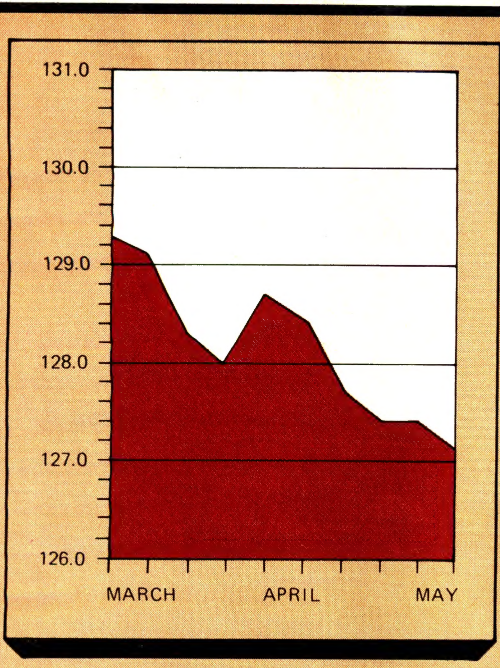
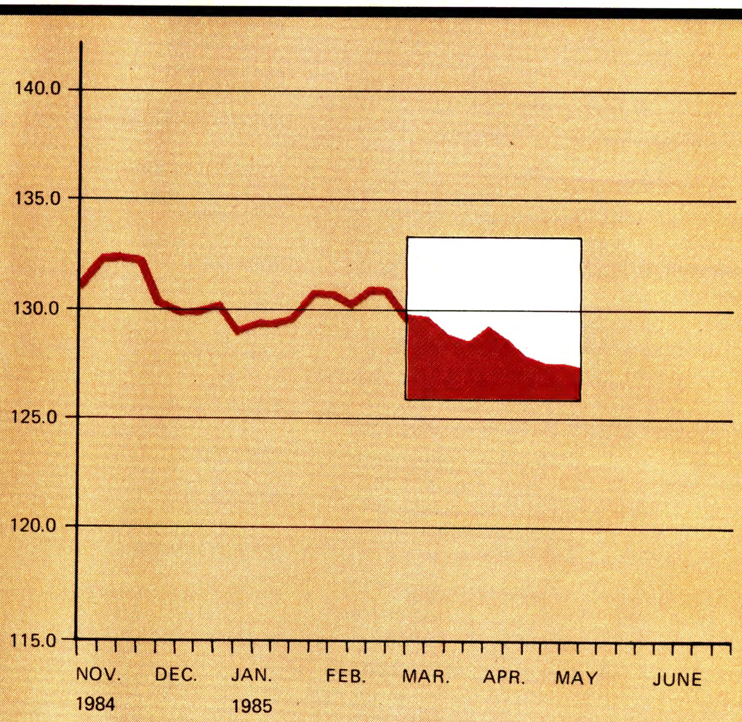


THIS WEEK = 127.1
LAST WEEK = 127.4
YEAR AGO = 123.9
1982 = 100.0



The *ElectronicsWeek* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U.S. ELECTRONICS INDUSTRY EMPLOYMENT

	March 1985	February 1985	March 1984
Average prime rate (%)	10.50	10.50	11.21
Retail sales (S billions)	110.541	112.736	104.525
Unemployment rate (%)	7.2	7.2	7.7

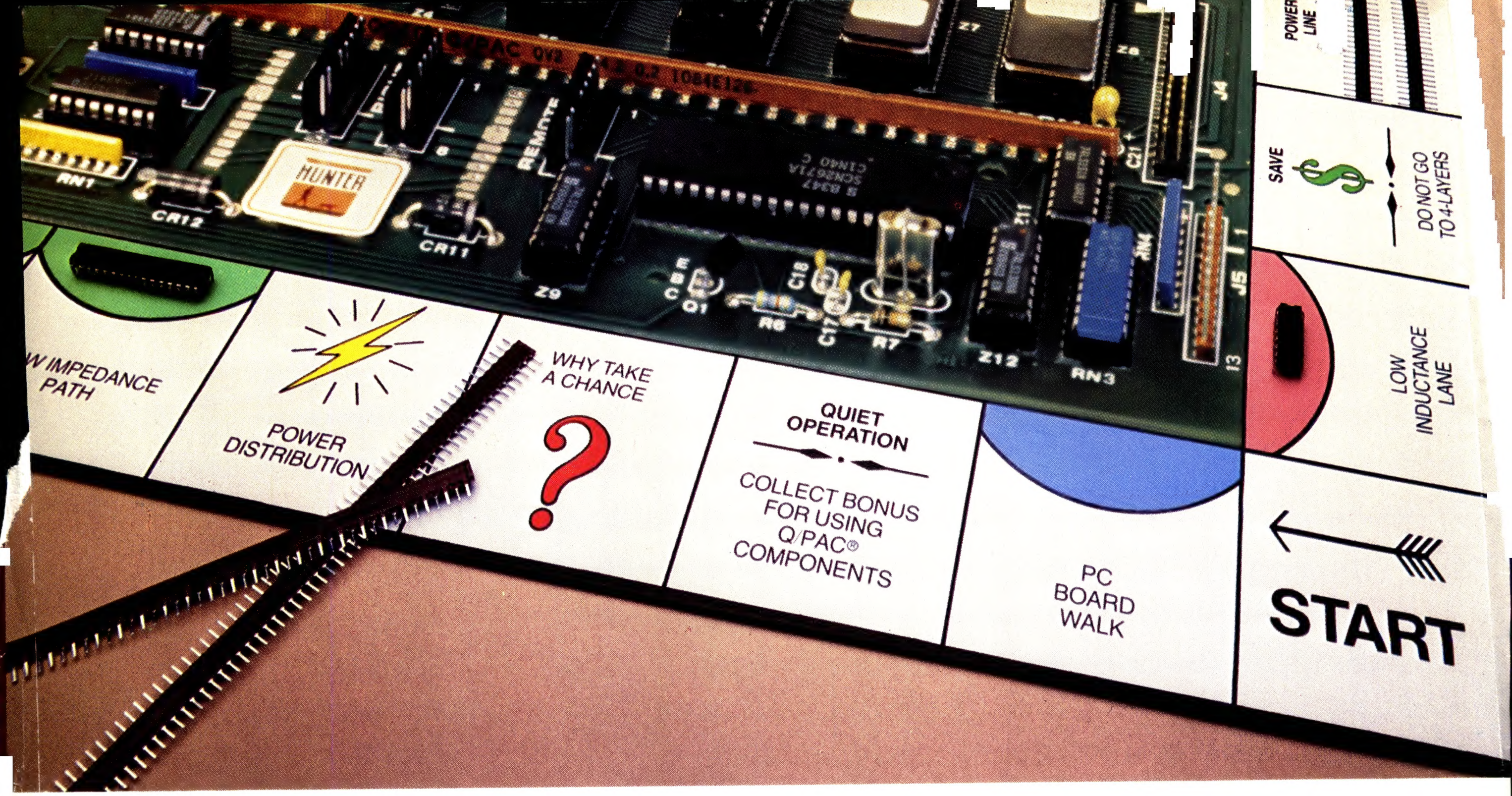
U.S. GENERAL ECONOMIC INDICATORS

Production workers (thousands)	March 1985	February 1985	March 1984
Office and computing machines	187.2	191.2	199.1
Communications equipment	299.8	297.3	275.6
Radio and TV receiving equipment	58.0	58.2	61.5
Components	401.6	409.4	402.1

Still-slipping levels of employment in the U.S. electronics industry brought the *ElectronicsWeek* Index down 0.2% in the latest week. Although employment of production workers among manufacturers of communications equipment racked up a gain of almost 1%, employment was lower across most other product lines. Workers at office and computing-equipment vendors suffered the most severe labor decline; their ranks were reduced by 2.1%.

The components industry wasn't far behind, however, as manufacturers cut their payrolls in the face of a continuing business slump. Employment in this sector of the electronics industry was down 1.9% in March, according to the latest government statistics. Employment among makers of communications equipment increased a scant 0.8% from the previous month. March employment levels in the radio and TV-equipment industry were essentially flat, dipping 0.3%.

Overall, the past year has been rather disastrous for workers in the U.S. electronics industry as reduced levels of business continue to prevail. From a year ago, employment among office equipment makers is down 6%, while worker rolls have been trimmed 5.7% in the radio and TV-equipment industry. Surprisingly, considering the problems in the industry, employment at components firm is down only 0.1%, according to the government data. On the general economic front, interest rates (another component of the Index) continued to slip a bit, and the unemployment rate is holding steady.



With Q/PAC® components, real estate becomes a whole new game!

Q/Pac® capacitive power distribution components give you 4-layer performance on a 2-layer board.

Get the jump on cost-effectiveness: You need a quiet board for efficient operation of logic or memory circuits, yet adding extra layers for power and ground forces you to pay a cost penalty. Rogers Q/Pac capacitive PCB bus bars take power distribution off-board to give you 4-layer quietness with a dependable, economical 2-layer board. Result: you save up to 50% in basic board costs.

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Circle 901 on reader service card

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Who manages the power in Harris Hybrid and Avionic Test Systems?

KEPCO® POWER MANAGERS™

The Harris Corporation Government Support Systems Division builds automatic test systems as part of their advanced maintenance support program for many of the U.S. Navy's most complex weapons systems.

Kepco's Series ATE **Power Managers,** interfaced to an IEEE bus through Kepco Series SN Digital Programmers, manage all controlled power requirements in Harris' Hybrid and Avionic Test Systems, furnishing the critical programmed test voltages to the unit under test.

Kepco **Power Managers** are fully programmable for both voltage and current through their entire rated range, and can deliver full-rated current *and* full-rated voltage at the same time.

For your ATE requirements, unipolar or bipolar, up to 2000 Volts and 1000 Watts, consider Kepco's versatile **Power Managers.**

Circle 902 on reader service card

This Harris AN/USM-484 Hybrid Test System incorporates 10 Kepco power supplies:

- three Kepco ATE 36-3M (0-36 Volts, 0-3 Amps)
- three ATE 100-1M (0-100 Volts, 0-1 Amp)
- one ATE 25-4M (0-25 Volts, 0-4 Amps)
- one ATE 6-10M (0-6 Volts, 0-10 Amps)
- one ATE 15-6M (0-15 Volts, 0-6 Amps)
- one ATE 55-2M (0-55 Volts, 0-2 Amps)

Programming these Power Managers to the appropriate test levels are one single channel Kepco SN 488-121, and four dual channel SN 488-122 digital interfaces that read their instructions from Harris' IEEE 488 bus and provide optically isolated commands to the Kepco Power Managers.

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